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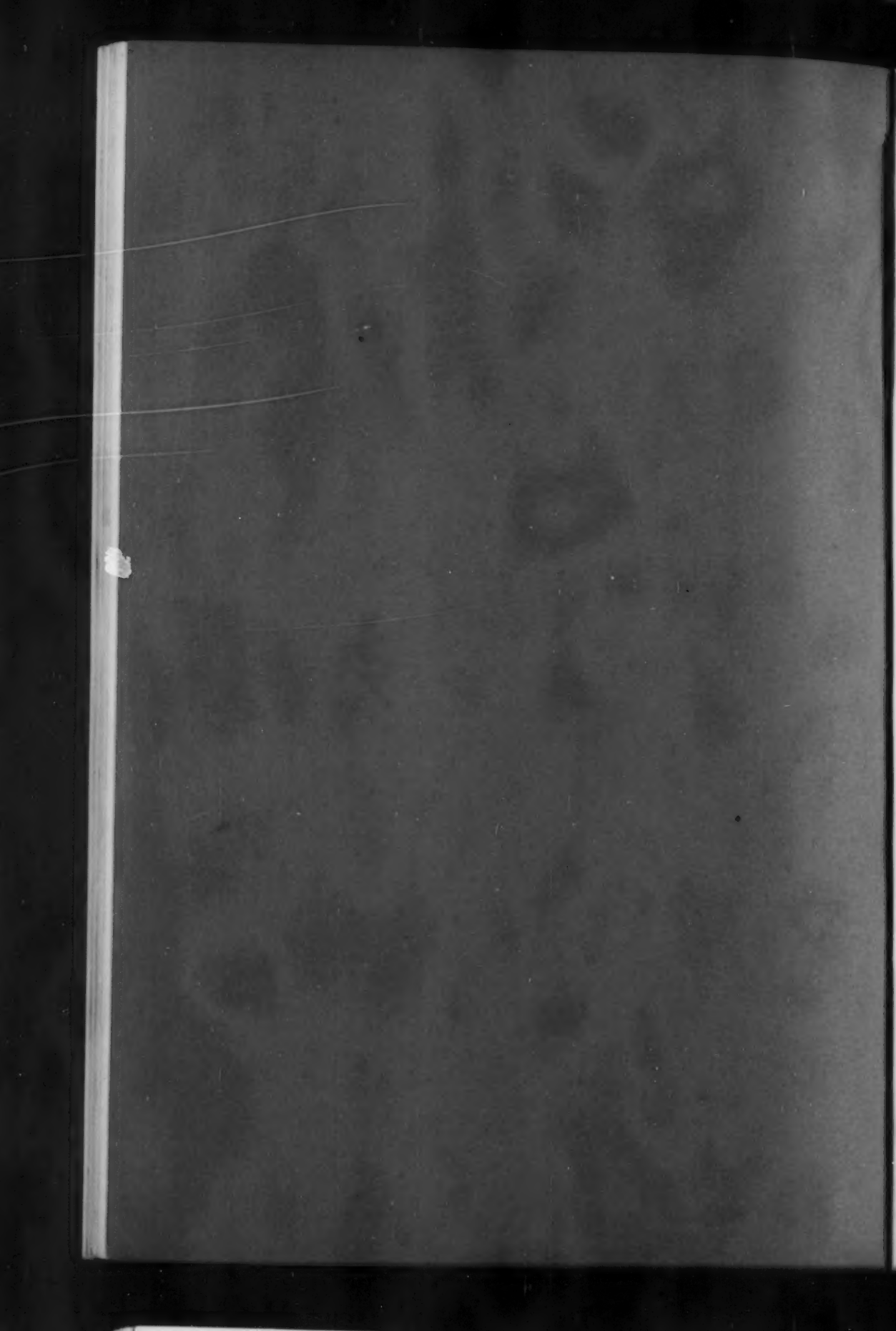

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NOVAYA ZEMLYA, A RUSSIAN ARCTIC LAND

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INTRODUCTORY AND HISTORICAL

The twin islands of Novaya Zemlya, curving like an immense arc from northwest to northeast, stretch northwards for no less than 1,000 kilometers into the Arctic Ocean, west of the point where European Russia touches Siberia. It was the efforts to find the northern sea passage to the rich countries of the East that led the first Western Europeans to Novaya Zemlya in the sixteenth century. The way to the White Sea and the mouth of the Dvina having been found by Chancellor on Sir Hugh Willoughby's well-known expedition in 1553,[1] the English Muscovy Company in 1556 sent out another expedition led by Stephen Burrough, who had taken part in Chancellor's voyage, with instructions to find his way to the Siberian rivers. He did not achieve this object but penetrated as far as the Kara Strait and the southern part of Novaya Zemlya. Nevertheless, Burrough cannot be called the discoverer of these islands, as they were already known to the Samoyeds and hunters of Northern Russia, who called them Novaya Zemlya, i.e. the New Land. During the last decade of the sixteenth century the Dutch began their voyages in the northeast. In 1596 Willem Barents' last and most famous voyage took place, on which occasion he first rediscovered Spitsbergen and then sailed round the northern cape of Novaya Zemlya. Afterwards, however, his ship was caught in the ice, and he had to winter on the east coast at about latitude 76° 15′ N. As is well known, Barents himself never returned. He died from illness, but his men, after an adventurous voyage, finally reached Kola in northern Russia in the ship's boats.

During the seventeenth century several important Dutch and English expeditions explored the seas around Novaya Zemlya, and well on in the

[1] Willoughby has been accredited with sighting Goose Land, the westernmost part of Novaya Zemlya, but Nordenskiöld does not consider this probable (The Voyage of the Vega, London, 1881, Vol. I, p. 62).

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FIG. 1.—Panorama from the southern side of Mashigin Fiord, western coast of Novaya Zemlya, at an altitude of 2,300 feet above sea level. (Photograph by R. Lund.)

eighteenth century the Russian explorations began. Of these the best known are Loschkin's and Rosmyslov's voyages about 1760. The latter explored the Matochkin Shar, the long winding sound which severs the country into two parts. But it was not until 1820 that the Russian authorities took up the exploration of Novaya Zemlya in earnest. Lieutenant (afterwards Admiral) Lütke investigated and mapped roughly large areas of the west coast in 1821–1824. Important geographical investigations were carried out on the east coast in 1832–1835 by Pakhtusov, the last two years in conjunction with Zivolka. Since that time the islands have been visited by numerous expeditions, both Russian and others, but it would carry us too far to take up in detail these more recent explorations. A great many European nations have at one time or another contributed to the work,[2] and I may mention that an especially important contribution to our knowledge of the northernmost part of Novaya Zemlya has been given by Norwegian sailors, who in their small sailing vessels have made numerous voyages in these waters, especially in the years about 1870, for seal, walrus, and polar bear hunting.

In spite of these explorations, however, Novaya Zemlya is still in many respects a little-known region. The east coast of the northern island, where, even in summer time, the drifting ice makes navigation es-

[2] See for example Charles Bénard: Dans l'Océan Glacial et en Nouvelle Zemble, Paris, 1909 (list of chief expeditions on pp. 189–190,) and *idem:* Un été chez les Samoyèdes, Paris, 1921, reviewed elsewhere in this number of the *Geographical Review*.

pecially difficult, is in every respect very little known, even from a purely geographical point of view. Not even the main features of the coast line are known. Detailed and correct maps are entirely lacking for practically the whole country; those which exist are mainly sea charts, including only a few limited areas, mostly on the southern island, principally near the Samoyed colonies.

FIG. 2—Outline map of Novaya Zemlya

GENERAL GEOGRAPHY AND PHYSIOGRAPHY

Novaya Zemlya is divided into two islands by the narrow Matochkin Strait. This dividing line, however, does not in any way signify a boundary between two areas of different character. The country just north of the sound, and that south of it, are in every respect identical both as regards surface formations and geology, and Novaya Zemlya may be regarded as a geographical unit. Stretching from latitude 70½° to 77° N. the island exhibits wide differences in the south and north, as regards the ice covering. There are also considerable differences in altitude. Novaya Zemlya is the remnant of an ancient mountain range folded up in Permian time. To a

great extent the same geological strata run lengthwise through the country, but the exposure of the several series of strata varies, and, as the various rocks weather very differently, we have a varied relief.

The middle part of the southern island shows a comparatively low, yet broken relief developed on strata of shale alternating with sandstone, a formation referred to as Permo-Carboniferous by the Russian geologist M. Chernyshev who in 1895 made a cross-country journey a little north of the 72nd parallel. A great part of the surface is less than 300 meters above sea level, and the greatest altitudes probably do not here exceed 500 meters. The low-lying Goose Land, the broad peninsula forming the westernmost part of Novaya Zemlya, has an average elevation of less than 70 meters above sea level. It is strewn with numerous large shallow lakes.

Both south and north but especially north of this middle area of the southern island we meet with higher country. To the south-southeast of Kostin Shar rise ridges that probably attain heights of 600–700 meters, whilst in the north, towards the Matochkin Strait, altitudes of 1,000 meters and over are found. These higher areas consist of a series of harder rocks, sandstones, quartzites, conglomerates, and dolomites which in part belong to the uppermost Cambrian,[3] in part to the Devonian, while in an extreme western belt are Carboniferous limestones. Chernyshev described a comparatively well defined boundary, along a line of faulting between the mountainous area near Matochkin Strait and the lower land to the south. In reality, however, no such fault seems to exist, and there is a gradual change in the landscape, which rises regularly to the north.

Between 73° and 75° there is along the west coast a strip of low, flat land sometimes as much as 10 kilometers in breadth and less than 100 meters in height. This strip—and no doubt Goose Land too—corresponds to the coastal plain, *strandflaten*, of Norway and Spitsbergen, cut by marine erosion at a time preceding the last complete glaciation of the islands. From this plain sharply defined mountains rise abruptly up to the height of 700–1,000 meters—probably nowhere exceeding 1,100 meters. Such elevations are maintained to about halfway across the island where the mountains gradually become lower, until near the east coast they give way to plateau-like landscapes, with altitudes of 300–500 meters. It is in these middle latitudes that we find the most typical fiord topography, with narrow fiords reaching from 30 to 40 kilometers inland. On the softer rocks of the mountain slopes we find a characteristic development of beautifully defined raised beaches, terraces cut in the shore line during a late Quaternary submergence of the land. The highest terrace that is undoubtedly marine lies 200–240 meters above sea level, the difference in different places being due to an uneven raising of different parts of the land mass. That these terraces represent old beaches is proved also by the occurrence of marine mollusks at corresponding heights. At Archangel Bay shells were found at a

[3] The recent examination of the paleontological material collected during the Norwegian expedition has shown the rather unexpected fact that the oldest Paleozoic formation is represented in Novaya Zemlya.

FIG. 3

FIG. 4

FIG. 5

FIG. 3—River on glacier on the Gorbori Islands, northwestern coast of Novaya Zemlya. (Photograph by O. T. Grönlie.)

FIG. 4—Glacial plateau about 1,650 feet above sea level north of the inner part of Mashigin Fiord. In the foreground the snow has melted, exposing the old dark ice. (Photograph by O. T. Grönlie.)

FIG. 5—Front of glacier (height about 100 feet) on the southern side of the narrow inner part of Mashigin Fiord. (Photograph by R. Lund.)

FIG. 6

FIG. 7

FIG. 6—The innermost part of Beasimyannii Fiord (Nameless Bay), western coast of Novaya Zemlya. Note the raised beaches on the fiord walls and the widespread delta deposits. (Photograph by R. Lund.)

FIG. 7—The middle part of Matochkin Strait, the channel dividing Novaya Zemlya into two islands. (Photograph by B. Lynge.)

FIG. 8

FIG. 9

FIG. 8—An Arctic desert. The southern side of Pankratyev Peninsula, northwestern coast. The cliffs defining the coast line are 30 to 60 feet high. (Photograph by B. Lynge.)

FIG. 9—Driftwood along the inner part of the bay on the southern side of Pankratyev Peninsula. Raised beaches at several levels are cut in the moraine hills in the background. Beyond is the inland ice. (Photograph by B. Lynge.)

height of 239 meters by the recent Norwegian expedition. Small isolated glaciers occur as far as 30–40 kilometers south of the Matochkin Strait but not farther south. No glacier reaches the sea along the strait, but one glacier on the north side has its lower end on the lowland very near the sound. From about 74° northwards glaciers reach the inner ends of the fiords, and their dimensions constantly increase northwards. On a sledge trip from the Mashigin Fiord to the Zivolka Fiord on the east coast, I crossed from coast to coast on glaciers whose surface was generally less than 400 meters above sea level.[4] Inland at these latitudes there is more ice surface than rock.

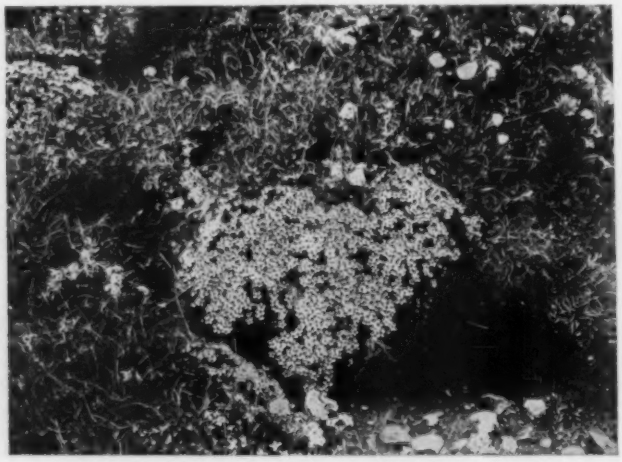

FIG. 10—Flowering plants of the eastern part of Matochkin Strait (latitude 73°N.). *Silene acaulis* with *Myosotis* and *Papaver*. (Photograph by B. Lynge.)

Farther north, the glaciers become still more dominant, and at 76° we may speak of inland ice. Practically speaking, the mountains rise above the ice only near the coasts. The ice there also forms an integral part of the coast line. The western coastal mountains north of 76° occasionally rise to 1,000 meters but are most often considerably less.[5] Concerning the east coast exceedingly little is as yet known.

BIOLOGY

The fauna and flora of Novaya Zemlya are in general very like those of Spitsbergen. The reindeer, which was formerly fairly common, is now mainly found along the east coast; and where the ice lies close to the shore the polar bear often lands. The polar fox also is rather common. Of smaller mammals there are species of lemming. In the fiords and on the ice near the

[4] Olaf Holtedahl: A Crossing of Novaya Zemlya, *Geogr. Journ.*, Vol. 59, 1922, pp. 370–375.

[5] Cf. the map made by Lieutenant Sedov's Wintering Expedition 1912–1913, published in L. Breitfuss's article on the expedition in *Zapiski po gidrografii*, Vol. 42, 1918, Petrograd.

coast we meet various species of seal (especially *Phoca barbata* and *P. foetida*) in great number, and on the east coast also the walrus. The white whale (*Delphinapterus leucas*), which was formerly very common, is still seen along the shores.

As in other Arctic islands, the main characteristic of the higher fauna is the bird life.[6] Geese of several species are seen in enormous numbers in the lowlands, especially on the southern island, eider-ducks are very common, and there are innumerable precipitous cliffs where thousands of looms (Brünnich's guillemots, *Lomvia bruennichi*) and various species of gulls

FIG. 11—Flowering plants at Serebryanka Bay, north of the western end of Matochkin Strait. *Valeriana capitata* and grasses.

(especially *Rissa tridactyla* and *Larus glaucus*) have their breeding places. There is also an abundance of smaller birds, among others several species of stints (*Tringa*) and the snow bunting (*Plectrophenax nivalis*), the latter being the most common land bird seen. Of larger land birds might be mentioned the snowy owl (*Nyctea scandiaca*). On the southern island Bewick's swan (*Cygnus bewicki*) is found. The rivers and lakes generally are poor in animal life, but a fine species of salmon, *Salmo alpinus*, occurs fairly commonly in some of the fiords of the western coast and enters the rivers there. At first sight insect life appears to be meager, nevertheless the number of species has proved to be very great; of one group alone, beetles, the Norwegian expedition last summer found some twenty species.

No trees nor erect bushes are to be found even on the southern island, yet flowering plants occur in fairly large numbers. A total of about 150 species has been found in the southern island. This number decreases farther north.

[6] Compare A. H. Markham: A Polar Reconnaissance, London, 1881, p. 151, and H. J. Pearson: Beyond Petsora Eastward, London, 1899.

Dr. Lynge, the botanist of the Norwegian expedition, found about 60 species on the west coast at about latitude 76°. Among the most common higher plants are species (about 10 in number) of Salix, their thin branches always creeping along the ground; also Saxifraga is represented by an equally large number of species.[7]

Nevertheless, there is an abundance of tree trunks to be found along the coast, carried there by the ocean currents chiefly from the Siberian estuaries. This Siberian timber has drifted a long distance before stranding here. It passes south of Franz Joseph Land, then drifts southwestward towards Bear Island, where it is caught by a drift from the Gulf Stream, the North Cape current, and carried along the Novaya Zemlya coasts. Incidentally it may be

FIG. 12—The Samoyed colonists at Pomors'kaya Bay, western end of Matoch'kin Strait. The little church in the background. (Photograph by R. Lund.)

remarked that to this warm current is due the circumstance that the greater part of the west coast in most years is fairly free from ice during late summer and early autumn; and it is this current which makes possible such a comparatively rich vegetation.

THE SAMOYEDS

Before 1870 Novaya Zemlya had no permanent inhabitants, whilst on the mainland to the south and on the island of Vaigach reindeer-keeping Samoyeds led a nomad life. On account of the length of time the northern coast of Russia remains icebound the riches of the sea near Novaya Zemlya were utilized more by Norwegian sealers than by the Russians. It was to remedy this state of affairs that there was started, by the initiative of the Grand Duke Alexis Alexandrovitch, a colonization of the southern island. In 1877 five Samoyed families, numbering in all 24 persons, were trans-

[7] A description of the flowering plants of Novaya Zemlya is given in the appendix by Col. H. W. Feilden to H. J. Pearson's "Beyond Petsora Eastward," London, 1899.

ported from the Russian mainland, from the Mezen district on the east side of the mouth of the White Sea, to Little Karmakul on the west coast of the southern island, somewhat to the north of Goose Land. Later on other families joined the first.[8] Some of them soon moved north to the entrance of Matochkin Strait (Pomorskaya Bay), where there were better opportunities for hunting polar bears. In 1897 a third colony was founded at Belushii Bay on the southern side of Goose Land, and finally a small colony has come into being in the inmost part of the Krestovii Fiord. Personally I have seen only the last-named and the colony at Pomorskaya Bay, and in both places there are but a small number of persons, in the Krestovii Fiord about 10 and at Pomorskaya about 30, children included. The more southern colonies are larger, and here Russian priests are stationed.

The Samoyeds live in solidly-built wooden houses, the material of which has been brought over from Russia. They live chiefly by hunting and salmon fishing and also receive every summer (in exchange for their furs) some provisions, more especially flour, sugar, tea, tobacco, arms, and ammunition, and other articles from Russia. Supplies, it may be noted, were received last summer. The Samoyeds wear garments of reindeer skin for the most part, though the women have bright-colored materials imported from the south for their "Sunday" clothes. They do not keep tame reindeer, but on the other hand they have a large number of dogs, which they employ to draw their light sledges. For a large part of the year the men are out hunting, taking with them their families and living in tents.

[8] See the account of the settlement made in 1894 by A. P. Engelhardt, Governor of the Province of Archangel, described in his book "A Russian Province of the North," London, 1899, pp. 198 *et seq.*

THE GEOGRAPHY OF FAIRS: ILLUSTRATED BY OLD-WORLD EXAMPLES

By André Allix
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The fair is one of the most characteristic features of Old-World commerce, whether considered historically or in respect of certain particular products. Yet it is a subject that has inspired little geographical study.[1] The reason doubtless lies in the fact that in all western Europe general fairs on a large scale are an institution of the past, while the surviving fairs are too restricted in their sphere of interest as regards place or products to have attracted attention. The recent sample fairs appear to represent a permanent feature of international trade, but their creation is too recent to have permitted geographical analysis.

From the geographical point of view the problem seems to have been complicated by the confusion of four analogous institutions which may exist side by side or in combination but which are fundamentally distinct and go back most probably to at least two different origins. In the one group figure the general commodity fair and the recently created sample fair; in the other the town market and the cattle fair. The commodity fair represents the sole mechanism of large-scale commerce, and especially international commerce, in a state of civilization, when there was no security for regular exchange nor were means of transportation organized; it has declined with the progress of material civilization. The sample fair is a creation of today and in some measure artificial. It is directly derived from the commodity fair though perhaps best described as a resurrection of it under an entirely new guise and adapted to modern needs.

The town market and the live-stock fair appear to have been united in the beginning and to have arisen from the same causes and the same geographical conditions. But they early became dissociated, responding to different needs, and finally became distinct. The town market which today retains its old-time characteristics is not germane to the present discussion. The live-stock fair, an apparent derivative of the commodity fair, is in reality an independent institution, perhaps the more ancient in its fundamentals and at all events the more persistent, for it still flourishes at the present time. Unlike the commodity fair it is not the response to changing economic and social conditions of a certain stage of civilization but to natural controls of pastoral life.

[1] Practically all the geographical studies written on this subject concern live-stock fairs (see pp. 546–557 of this article). See also G. M. Wrigley: Fairs of the Central Andes, *Geogr. Rev.*, Vol 7, 1919, pp. 65–80. The works already published on the subject of fairs, though almost exclusively by historians and jurists, furnish abundant documentary material from which it is possible to draw clear ideas as to the nature of the institution in its geographical implications.

Commodity Fairs[2]

Origin of Fairs

Travelers in primitive countries often remark the more or less periodic gathering at customary places and dates of men from different tribes representing unlike modes of life—that is of people having products to exchange. The animated crowd trafficking one day in the midst of dust and noise is dispersed in the evening to regain the more or less secluded and fortified places where the daily existence of the tribes is pursued. In this way arises a primi-

Fig. 1—Market fair in northern Africa held in the open country. The weekly fair of Suk-el-Jemaa in Kabylia. (Photograph by Raoul Blanchard.)

tive commercial organ permitting backward folk to reconcile two contradictory needs; seclusion for safety and intercourse for exchange.

The place of exchange is a sort of *neutral ground*, and the period of exchange a *truce* where the normal state of existence, if not of warfare, is at least of hostile indifference.[3] In its rudimentary form this kind of commerce is what German writers have termed *Grenzhandel*, "frontier commerce."[4]

[2] A wealth of facts and valuable bibliographical references are to be found in Paul Huvelin: Essai historique sur le droit des marchés et des foires, Paris, 1897. See also Cornelius Walford: Fairs, Past and Present, A Chapter in the History of Commerce, London, 1883.

[3] Numerous instances of the neutral character of these primitive trading assemblies are given by P. J. Hamilton Grierson in "The Silent Trade" (Edinburgh, 1903) in a section of which is traced the connection between the primitive market and the still more primitive commercial method of the "silent trade." R. Hennig in "Der 'Stumme Handel' als pandemische Erscheinung" (*Zeitschr. für Sozialwissenschaft*, Vol. 10, 1920, pp. 10–12, Leipzig), also expresses the opinion that the "blind and dumb" trade of primitive peoples is the origin of large-scale commerce and especially of commerce by fairs.

[4] Fr. Graebner: Handel bei Naturvölkern, in Karl Andree's "Geographie des Welthandels" (3 vols., Frankfurt on the Main, 1910–13), Vol. 1, pp. 149–218; reference on pp. 158 *et seq.*

In the South Sea Islands the sound of a sacred drum announces the opening and closing of the truce. On the Congo during the period devoted to commerce the carrying of arms is strictly interdicted. By reason of their nature these meetings generally avoid inhabited places, a primitive feature that is often long persistent. In Africa today most of the periodic markets are held in the open country.[5]

Upon such gatherings for exchange nature imposes a certain periodicity more or less related to the variations of the season and the working calendar of these "nature" people, *Naturvölker* of the German writers. The periodicity may be of considerable amplitude: among the nomads of northern Asia commercial contact with the outside world is made only once a year.[6] When the requirements of exchange become more complex merchandise must be transported from a distance. But the ways of communication are still the rough roads furnished by nature. Security is precarious. Every convoy must be organized to withstand the natural perils and the menace of pillage; thus arises the caravan. Normally the caravan is a numerous body every member of which is assigned his definite function under the absolute authority and conduct of a responsible chief. The familiar comparison between a caravan and a ship may be recalled.

At this stage of civilization the only vehicle of commerce on a large scale is the caravan. Now by definition it functions intermittently, hence commerce must also be intermittent. To minimize inconvenience movements of caravans at an early date became regular, that is periodic. It was thus in the times of Herodotus and Strabo, as it is now the rule in Arab countries. Naturally the return of caravans at fixed times to their accustomed "ports" was followed by gatherings for trade. As the great religious festivals also drew great concourses of people, it was mutually advantageous to have them coincident: the caravans found it to their interest to arrive at the times of the festivals; the sovereign power that established the fairs—as was the case in historic times for the most part—fixed them on the great feast days. The word "fair" (the etymology is no longer in doubt) is from *feriae*, feast.

It may be remarked that in Christian countries the great festivals which most often accompany the great fairs are those of the warm season. They are Easter, Whitsuntide, Trinity; then the six great saints' days which follow month by month—St. John (June 24), St. James (July 24), St. Bartholomew (August 24), St. Matthew (September 21), St. Simon and St. Jude (October 28), and St. Andrew (November 30). Some fairs occur at Christmas and Epiphany, but they are less numerous. In the non-Christian countries there is a similar resemblance between the religious, the commercial, and the climatic rhythm. Political anniversaries sometimes play a like part to the religious festivals.

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[5] Giotto Dainelli and Olinto Marinelli: Risultati scientifici di un viaggio nella Colonia Eritrea. Florence, 1912.

[6] Graebner, *op. cit.*, p. 163.

Yet there are fairs which now at least do not appear to correspond to any festival date, and such cases are not infrequent. In some instances—and these are rare—the two events appear never to have been coincident; in others—as is ordinarily the case—they were originally connected but for reasons of convenience have been dissociated. And again the festival phase can survive the fair proper, of which it may remain the only souvenir.

However, the fair, because it is a commercial institution, will naturally be far more dependent on the physical conditions ruling the movement of caravans than on the social and historic factors regulating the feasts. But, as we have pointed out, coincidence of the fair with a feast augments its chances of continued success. Under this more complex form the commodity fair remains much as we have defined it in its primitive state. It arises from the combination of the two factors, frontier commerce and caravan transport.

The Great Commodity Fairs: Historical Summary

The most ancient association between caravan trade and the fair goes back to China in the twelfth century before our era.[7] It is seen in ancient India, in the days of Babylon and Nineveh, then in Egypt, Nubia, and Arabia at the time when the Phoenicians were the great intermediaries of international commerce.[8] The national assemblies of ancient Greece with their religious ceremonials and games were at the same time the opportunity for merchandise fairs. The most important of these, owing to an admirable geographical position, were those of Corinth, seat of the Isthmian Games.[9] Significantly enough, under the Roman Empire the rôle of the fairs diminished, thanks to the *pax romana*, which guaranteed regular trade sufficient security and facility of transport.[10] But this was only temporary: the barbarian invasions followed.

At the beginning of the Middle Ages, during the "Frankish period," it is known[11] that a considerable number of fairs were legally guaranteed and frequented by international merchants; Greeks, Syrians, and Berbers there met Frisians and Saxons. Amongst these fairs the origin of some can be traced to the Roman period; others had their beginnings in the Germanic juridical institutions (*malli* or *placita*); others, the most numerous and important, were established on the occasion of festivals and Christian pilgrimages. The first known fair under this form is that of Saint Denis, near Paris, established by the Frankish monarch in 629 under a charter which was renewed three times in the following century. This fair, which appears to have changed its date in the ninth century, remained for five hundred years one of the centers of European commerce.

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[7] E. C. Biot, transl.: Le Tcheou-li, ou rites des Tcheou, 2 vols., Paris, 1851.

[8] F. K. Movers: Die Phönizier, 3 vols (uncompleted), Berlin, 1841–59; reference in Vol. 2, Section 3 (Handel und Schiffahrt), pp. 134 *et sqq.*

[9] Huvelin, *op. cit.*, pp. 75 *et sqq.* (ancient texts quoted and bibliography); Walford, *op. cit.*, pp. 3 *et sqq.*

[10] Huvelin, *op. cit.*, pp. 80–135.

[11] *Ibid*, pp. 143–176.

Up to the fifteenth century it was the French fairs that played the chief rôle in western Europe. From the twelfth to the fourteenth centuries those of Champagne[12] and Flanders[13] led in importance. They were regularly frequented by merchants from all parts of Europe and all northern Africa, Palestine and Syria, and Asia Minor. The Italians in particular enjoyed a

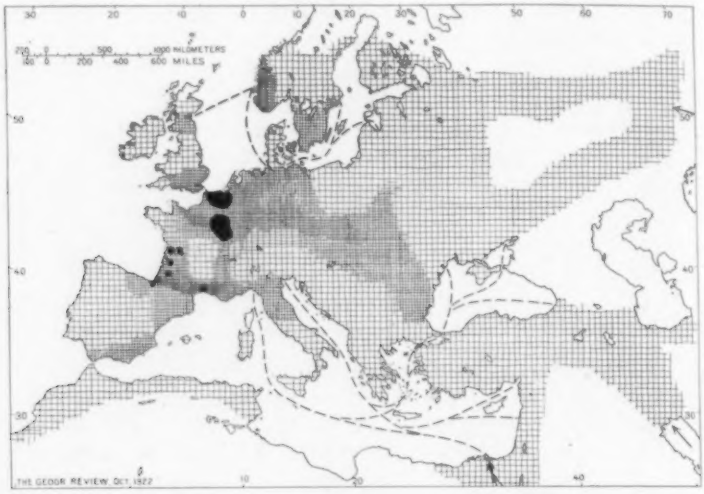

FIG. 2—The economic sphere of the most important commodity fairs of Europe in the twelfth to fifteenth centuries; the fairs of Champagne and Flanders. The large black patches represent the territory over which the fairs were held, Champagne to the south, Flanders to the north. The hachures represent the regions having regular relations with the fairs, the depth of shading corresponding approximately to the degree of relative importance. Broken lines show the principal routes of maritime traffic, and arrows the direction of imports brought from the Far East (*a*) by Arab navigators, (*b*) by Russo-Chinese caravans.

notable share of the business of the fair, sharing the monopoly in banking operations with the Jews. They were also great importers of eastern goods bought by Genoese and Venetian mariners from Arab traders or Russian caravans on the shores of the Black Sea and the Nile delta. One of the characteristics of these two great fairs was that they were not held at single centers: they may be described as constellations of fairs. Those of Champagne were held in four towns, Provins, Troyes, Bar-sur-Aube, and Lagny-sur-Marne; those of Flanders in several places but more particularly at Thourout, Bruges, Ypres, Lille, and later at Ghent and Antwerp. The chief advantage of this subdivision was that, passing on from one center to another, the fairs were distributed throughout the year and thus in fact constituted a permanent market.

[12] Félix Bourquelot: Études sur les foires de Champagne, 2 vols., *Mémoires Présentés . . . à l'Acad. des Inscriptions et Belles Lettres*, Ser. 2, Vol. 5, Paris, 1865.

[13] Victor Gaillard: Essai sur le commerce de la Flandre au moyen-age: Troisième étude, les foires, Ghent, 1851.

In the fifteenth century European commerce was shared between two rival fairs, Geneva[14] and Lyons.[15] After long strife Lyons gained the ascendancy and until the middle of the sixteenth century held unquestioned supremacy among the fairs of Christendom. The Lyons fair was held for the period of a fortnight four times a year—in January, at Easter, in August, and

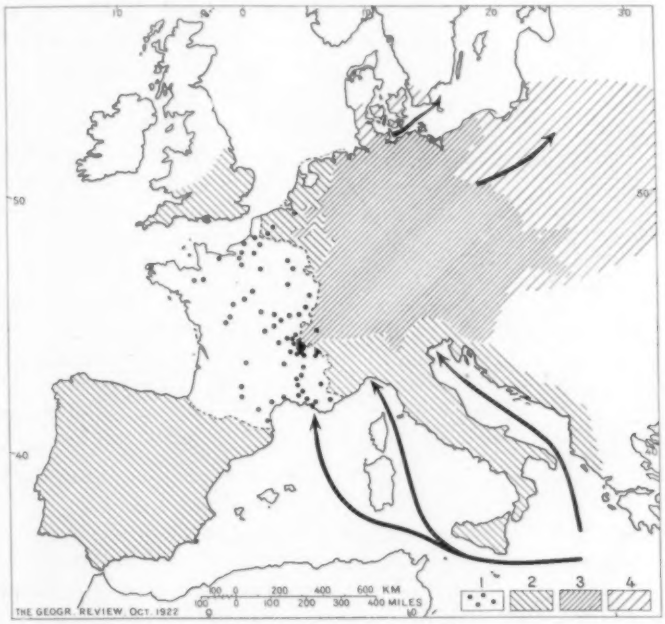

FIG. 3—The economic sphere of the sixteenth-century fair of Lyons. The numbers have reference to the fair: 1, chief industrial towns sending thither merchandise; 2, foreign countries especially interested in import; 3, countries chiefly interested in export; 4, countries of re-exportation. Arrows show direction of importation from the East and re-exportation to northern and eastern Europe.

in November. It was not only the central organ of exchange for the various regions of France but by its location as the point of transit for foreign commerce was a European rather than a French fair. It was through this fair that the products of the Mediterranean and the East were put into general circulation; notably it provisioned the German fairs, which in turn distributed merchandise throughout northern and eastern Europe.

The golden age of the German fairs[16] commenced later, though they have an origin almost as ancient as those of France. Cologne dates from 973, Mainz from 975, Leipzig from 1268. But they only assumed an international

[14] Frédéric Borel: Les foires de Genève au quinzième siècle, Geneva and Paris, 1892.

[15] Marc Brésard: Les foires de Lyon aux XVe et XVIe siècles, Paris, 1914.

[16] Philippi: Beiträge zur Geschichte und Statistik der deutschen Messen, Frankfort on the Oder, 1858. R. Ehrenberg: Das Zeitalter der Fugger, 2 vols., Jena, 1896.

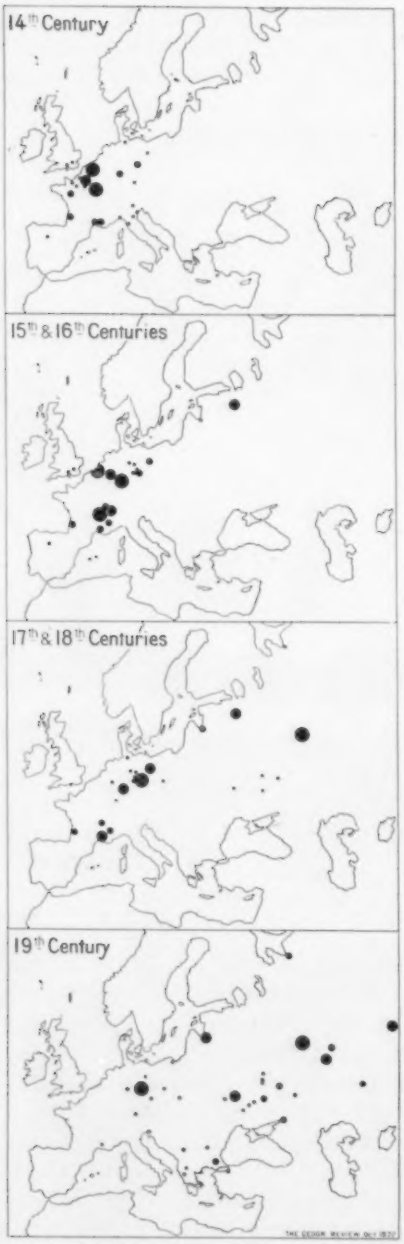

FIG. 4—The eastward migration of the great commodity fairs of Europe. Circles of four orders of magnitude are used to show approximate importance.

aspect when the religious wars waged in France in the sixteenth century had destroyed the security of that country's fairs; while at the same time the great axes of European trade were displaced from the Mediterranean to the Atlantic and the North Sea. During the sixteenth century the preponderant rôle was held by Frankfort on the Main;[17] after the Thirty Years' War it passed to Leipzig, which kept it until the nineteenth century.[18] After a long period of rivalry the German fairs ended by dividing the year between them as the fairs of Flanders and Champagne had done. A rotation embracing the two fairs of Leipzig, the two fairs of Frankfurt on the Main, the fairs of Naumburg and Frankfurt on the Oder provided a continuous market. However, the business of the German fairs in transit trade and exportation was more limited than that of the old French fairs; as contemporary writers say, they were especially import fairs, *Einfuhrmessen*.

At last, in the nineteenth century, the German fairs declined in their turn, giving place to the Russian fairs. The Russian fairs, which date only from the close of the Middle Ages, began to attract large gatherings in the fifteenth century. The fair of Novgorod the Great then figured as the chief me-

[17] Richard Bettgenhaeuser: Die Mainz-Frankfurter Marktschifffahrt in Mittelalter (Leipziger Studien, Vol. 2, No. 1), Leipzig, 1896. Henri Estienne: Francofordiense emporium, sive francofordienses nundinae, Geneva, 1574.

[18] Ernst Hasse: Geschichte der Leipziger Messen, *Preisschr. Fürstl. Jablonowski'schen Gesell. zu Leipzig, No. 25*, 1885. Philippi: Die Messen der Stadt Frankfurt an der Oder, Frankfurt on the Oder, 1877.

dium for the distribution of German merchandise in Russia and Asia and of Asiatic goods in the Russian and the Baltic countries. Fairs had long been held at various points in the debatable ground between Slav and Asiatic. The most important of them seems to have been held since the ninth century in various places, first on the banks of the Volga at the confluence of the Kama and then at Kazan. Finally in the first half of the seventeenth century, owing to the great concourse of pilgrims to the old established monastery of Makariev, the fair was settled at this point, about 40 miles from the confluence of the Oka and Volga, at a date just before the feast of St. Macarius (September 5). In 1817 it was moved to Nijni Novgorod at the actual confluence,[19] where it has flourished up to the present day. It has been customary to hold the fair for four to six weeks a year from the 15th of July (Old Style) to the 25th of August officially and in fact to September 10 (Old Style). It was visited annually by some 200,000 persons and had a turnover of hundreds of millions of rubles (246,000,000, the maximum, in 1881). This famous fair has held an exceptional position as the place of exchange between Europe and Asia. There were brought together all objects of commerce; but cotton goods, skins, furs, and tea from China held the first place. Other well-known Russian fairs include those of Riga, Archangel, Kharkov, and Kiev; and there are numerous Russo-Asiatic fairs in Siberia and Central Asia.

The same epoch that saw the Russian fairs flourish saw also the development of fairs in Asiatic Turkey and the Balkans, where special note may be made of the fair of Usunji in the vilayet of Adrianople which thrived during a quarter of a century.[20] Finally it may be observed that in Mecca there still exists a fine example of a fair intimately related to an ancient pilgrimage and to caravan movement. The greater part of the native commerce in Africa also, as in the interior of Asia, is still carried on in the form of commodity fairs, and new ones are still being established.[21]

General Characteristics of Commodity Fairs: Periodicity

Periodicity is the most obvious trait of the commodity fair and that which has been commonly regarded as most fundamental.[22] In reality the periodicities of fairs are very diverse, both as regards relative frequency and seasonal occurrence, an indication in itself that this variation is not according to a rigid geographical rule. The most one can say is that fairs of the fine season predominate. Furthermore, there exist instances of non-periodic fairs—such as are held in ports on the arrival of ships. If the port has a con-

[19] V. Vinogradoff: Les foires, in M. W. de Kovalevsky: La Russie à la fin du XIXe siècle, Paris, 1900, pp. 646 *et seq.* H. P. Kennard: The Russian Year-book for 1911, for 1912, etc., London. Die Messe zu Nishnij-Nowgorod, Umsatz und Preise in den Jahren 1864–1873, *Russische Rev.*, Vol. 6, 1875, pp. 34–69, St. Petersburg. H. A. M. Butler-Johnstone: A Trip up the Volga to the Fair of Nijni-Novgorod, London, 1875. The question of Russian fairs has been summarized by Édouard Herriot, cited below (footnote 43).

[20] Karl Andree: Geographie des Welthandels, 3 vols., Stuttgart, 1867–77; reference in Vol. 1, pp. 54–176.

[21] For an example of a present-day establishment of a biennial fair in the Sahara see René Bazin: Charles de Foucauld, explorateur du Maroc, ermite au Sahara, Paris, 1921, pp. 377–378.

[22] Huvelin, *op. cit.*, p. 36.

siderable size, Marseilles or Bordeaux for example, or if it is the rendezvous of periodic maritime convoys, as the Hispanic-American galleons in the sixteenth and seventeenth centuries, it may become the seat of "maritime fairs" held at fixed times. In some instances combinations of fairs, as we have seen, fill the entire cycle of the year, merchants and merchandise traveling from one to the other. As a matter of fact, periodicity is rather a superficial trait, a convenient device which conceals a characteristic of much more fundamental importance, described more fully below, *the itinerancy of the traders and their merchandise.*

Security of the Fair

The charter of the fair always gave guarantees of and assured the privileges of protection. Merchants proceeding to an international fair obtained a kind of special passport, the "conduct of the fair" (*conduit*), which assured them and their merchandise free passage on certain defined routes and during a prescribed time. The great fairs exercised a sort of jurisdiction along the routes of travel even in foreign countries. The chiefs or wardens of the fairs of Champagne in the thirteenth century intervened on behalf of their merchants in Lorraine, Provence, and Italy, and obtained satisfaction.

International Character of the Fair

At the fair itself the same guarantees of security were offered by the "peace of the fair." Under its aegis commercial transactions were carried on even by merchants of enemy nations. Currency of all nations was in circulation; there was a money exchange and even rudimentary forms of money-order clearing. Generally each nation had its warehouses and inns, just as may be seen today in the *fonduks* of the countries of Arab speech.

In every epoch it was the fairs of the frontiers that flourished best. Those of Champagne near the Flemish border declined when independent Champagne became French, losing its character of a neutral country. Those of Lyons owed their success to proximity to the Swiss and Italian frontiers. This circumstance was indeed taken up as a matter of reproach by their rivals, and an attempt was made to remove the fair to central France, at Tours; but the attempt failed, and the fair returned to Lyons. Like happenings occurred in the history of the fairs of Frankfurt on the Main and Leipzig, and the triumph of Nijni Novgorod over Novgorod the Great is to be explained by the nearness of the former to Asia. In this last instance we return to a highly perfected form of our original frontier commerce, to the origin of the commodity fair and one of its most distinctive traits surpassed in importance only by its essential nomadism.

The Traveling Merchant and the Fair

To maintain his business uninterruptedly the merchant trader had to travel from fair to fair. He was able to do this by the combination of the

dates and rhythms of the various fairs—this indeed is the chief significance of their periodicity. In the thirteenth century, for instance, the same merchant might be found traveling in Champagne, Flanders, Spain, Italy, and Germany. He carried along with him merchandise bought and sold in the course of his journeys in the measure of his particular interests; he played in some degree a rôle analogous to that of the tramp ship on the ocean today. Sometimes, in consequence of developments in local or general conditions, or because of accidents en route or change of needs, supply would exceed demand, and the fair would be especially favorable to the buyer; sometimes the converse would be the case; but generally, owing to the itinerant character of the trade, supply and demand met. It must, however, be noted that merchandise, in bulk, was transported *before being sold* with the intention of being offered for sale, a fact which perhaps constitutes the chief difference with ordinary commerce of today.

In each of the fairs that he visited the itinerant trader met for the most part the same customers, debtors, and creditors. Thus it became customary to designate the fairs as the dates when accounts fell due. Some fairs were established for the express purpose of serving as a financial offset to others; as, for instance, was the case with the fair of Ríoseco in Spain founded in the sixteenth century in correspondence with one of the four fairs of Lyons, the only one which had not its counterpart in Spain. For the trader constrained to travel the year round the fair was naturally the only place for the balancing of accounts. This was, in later years, much the most important function of the fair of Nijni Novgorod.

Finally the fairs themselves are subject to a sort of migration or displacement. In general they do not prosper for long in the same place. A fair such as that of Leipzig, maintained uninterruptedly through eight centuries, is extremely unusual. Some fairs in fact are not fixed at all; that of Besançon, established in the fifteenth century and chiefly frequented by Italian merchants and bankers, was held successively at Poligny in the Jura, Chambéry in the Alps, and Piacenza, Asti, Novi in Italy, and finally near Genoa. This also was the case with the great Russian fair before its settlement at Nijni Novgorod as has been described above. The fair is only accidentally connected with a town and because it finds there temporary advantage. An organ of itinerant trade, its fate is in no wise related to that of the fixed organism, the town.

Location of Fairs

It is unnecessary to dwell on the fact that the great fairs have succeeded because of their situation on great highways of communication. A map showing a country's fairs at the time of their apogee will show them on the great trade routes of the time. Every fair had its sphere of influence on the borders of which it came in contact with other fairs, and the history of fairs is full of reciprocal encroachments. From the strife between rivals would arise for a time fairs of the first magnitude that in turn would be

supplanted by others, in part from geographical causes but also from political and social developments—changes of boundary or of political régime or diversion of trade currents. Each case requires individual analysis.

Sites of fairs chosen exclusively for reasons of a sentimental order, for example pilgrimages and holy places, are generally inferior to those selected for reasons of material advantage; yet there are instances where the influx of pilgrims constitutes a commercial advantage in itself and where it has made the fortune of an otherwise ill-favored place. Such is more particularly the case in countries where religion figures as a political force—the Mohammedan lands, China, or Christian Europe prior to the Middle Ages.

But ordinarily two classes of circumstances favor the location, for the time being, of the itinerant commerce of the fair. In the first instance selection may be made of the centers of producing regions. Thus the Flemish fairs were essentially the outlet of the seventeen cloth-manufacturing towns which in the Middle Ages made Flanders the first textile region of the continent. The fairs of Lyons assured the sale and provisioning of the industrial centers already scattered over France in the sixteenth century and in particular the two industries then created at Lyons itself, the silk and book trades.

Or again this itinerant trade is fixed for the time being in places of transit and at crossroads especially, as we have seen in frontier regions, for example in Champagne, at Breslau, and the two Frankforts.

When the two circumstances are combined—the producing region and the crossing of great highways—one finds exceptional conditions making the fortune of a Lyons or a Leipzig.

The Fair of Kiev

It also happens that the fair facilitates exchange and intercourse in a region almost purely rural where the inhabitants have no other opportunity for communicating with the outside world. This is the condition which gives rise to the live-stock fairs, but it has also been responsible for the creation of certain commodity fairs or of the two kinds of fairs in combination. A good illustration is afforded by the fair of Kiev, the so-called "contract fair" or, because of the date (February 5 to 25), the fair of the Purification. There transactions are carried on in cash or in terms of the products of the region—grain, sugar, alcohol, coal, metals; the affairs of the sugar industry are settled for the year; contracts are made for agricultural labor and for the sale and renting of land. It is at one and the same time a local, rural and industrial, and an international fair at which is made historic contact between the Mediterranean and the Slav regions.

Connection Between Fairs and Towns

Fairs also develop as a natural consequence of nomadism in countries where that is the normal form of life. It may be that no town exists and

the fair is held in the open country. It may be, as at Timbuktu, that the town is only an isolated point of fixed habitation around which centers the nomad life. In such circumstances, and especially in the last instance, fairs may give rise to fixed centers of population or encourage their growth to a marked degree. A town such as Nijni Novgorod which owes everything to its fair and lives almost entirely for it is an exception. When there is superposition of a fair and a town the two institutions are entirely distinct: even at Nijni Novgorod this is true. The fair is a supplementary

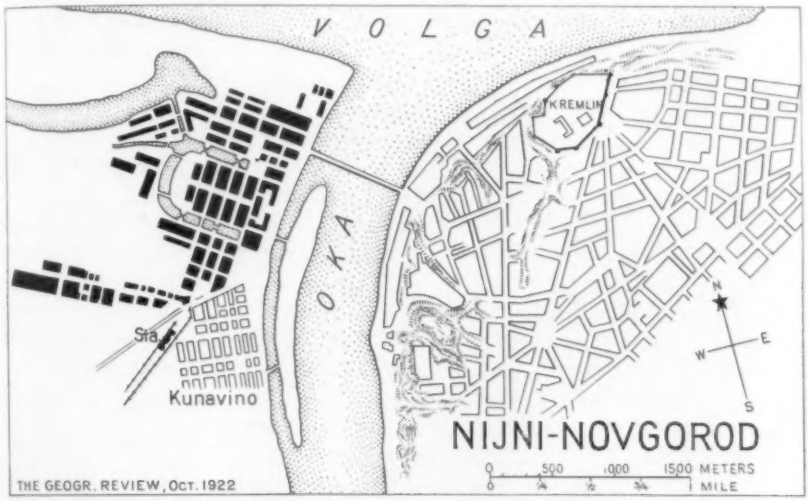

FIG. 5—Nijni Novgorod, the town and the fair. The ground to the east of the permanent buildings of the fair is covered with temporary structures during the period of the fair; the (wooden) bridge across the Oka is also temporary. For a view of town and fair see Figure 3 illustrating the article, "The Economic Resources of the Russian Empire," by E. K. Reynolds, *Geogr. Rev.*, Vol. 1, 1916, p. 254.

town, a parasite in a certain sense, sometimes incorporated in the fixed town for the time but more often existing in juxtaposition. The administration is not the same; the laws of government are different. There is a sort of "right of the fair" to which there is nothing corresponding in the town. A merchant from the town who wishes to engage in trade in the fair must carry thither his goods, and he has no advantage over the stranger.[23]

Furthermore, the fair has its own installations varying greatly in appearance according to the country and time to which they pertain. It may possess edifices of stone although they are only used intermittently, as at Nijni Novgorod where such buildings have a frontage of 1,800 meters, or the ancient halls, *halles*, of the Geneva fairs. There merchants are generally grouped according to commodities, as is done in the *suks* of the Mohammedan towns. In other cases the fair is only a temporary camp hastily erected

[23] Bourquelot, *op. cit.*, Vol. 1, pp. 77 and 324; Vol. 2, pp. 253 *et seq.* Borel, *op. cit.*, p. 92. Brésard, *op. cit.*, pp. 112 *et seq.* Huvelin, *op. cit.*, pp. 76 and 81.

on the eve of its opening on the "fair ground." Then it is composed of tents and huts, such as, for instance, were ranged along the banks of the Saône for the ancient fair of Lyons. On the other hand, the fair may be held in town buildings, public as well as private, as for the most part in the fairs of Flanders, Champagne, and Germany, notably at Leipzig. Or, yet again, the three forms may exist in combination, as happens more particularly in the case of well-to-do fairs.

The fair also has its own personnel and administration. It has its special police and judges, distinct from those of the town, who settle disputes according to the custom of the fair, not of the town. Money dealers, "bankers in the fair," who are not interested in business in the town, regulate the money exchange and the mechanism of credit. Up to our own days the great European banks have been represented in Nijni Novgorod only during the time of the fair. Finally, there is a host of brokers and middlemen whose special business is as old as that of the fair and is rendered necessary by its international character. They are licensed agents holding a legal status whose business is entirely separated from that of the town. A tradition of probity attaches to their transactions, which are carried on with a minimum of written guarantee, often by word of mouth alone. This characteristic is clearly indicated in the fairs of ancient Greece, and one sees it today among the cattle brokers of the fairs of western Europe. Obviously it is a trait of itinerant commerce which cannot be embarrassed with papers and procedures and must live on trust.[24]

These facts explain clearly why great fairs have often been long associated with small towns. This was the case at Beaucaire in southern France near the mouth of the Rhone, at the door of the commercial world of the Mediterranean and the Orient, and similarly at Briançon, the frontier town of the French Alps (altitude 1,326 meters) on the great road to Italy.[25] It was for long the case with St. Dénis, at the doors of Paris. Undoubtedly the town derived some benefit from the fair, but less than is commonly thought. It is the town treasury and the inns that gain the greatest advantage; local trade scarcely profits at all. The fair greatly increases the population, but in a purely momentary fashion. It sometimes happens that a powerful town, well-favored in its site and geographical position, creates a fair to add to its renown. Such is the case of Lyons; but the origin of the fair is dissociated from that of the town which gave it birth. The fair is of a nature entirely different from that of the town with which it has only superficial relations.

Decline of the Commodity Fairs

In the measure in which material civilization perfects means of exchange and communications and assures the commercial world increasing security,

[24] Huvelin, *op. cit.*, p. 74, note 5; André Allix; La foire de Goncelin, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 2, 1914, pp. 299–334.

[25] Henry Petiot: Briançon: Esquisse de géographie urbaine, *Rev. de Géogr. Alpine*, Vol. 9, 1921, pp. 341–456. Grenoble.

the conditions which rendered necessary the expedient of the commodity fair progressively disappear, and the fairs must decline or suffer transformation. We have, for instance, a contemporary example in the decline of the fair of Irbit since 1885, the date of construction of the railroad from the Urals. International traders cease to frequent the fairs in person, employing representatives or "factors" and finally abandoning them completely to retail trade. Monetary transactions are carried on more and more by permanent exchanges and clearing houses. Merchandise is shipped only on order; sales are made on sample, and it is no longer necessary for buyers and sellers to meet before the actual goods. The system of fairs is superseded for wholesale trade. Large-scale commerce has become rooted in permanent centers between which in all directions and at all seasons travel individuals, samples, and uninterrupted currents of correspondence and goods.

Yet the immediate effect of this fixation of commerce is not to diminish the *number* of fairs. On the contrary, as their importance declines their number increases. As the great international fairs disappear, little local fairs arise; in the last two centuries France has been sprinkled over with them, but many have only an ephemeral existence. They tend to degenerate into mere periodic amusements. Thus over the greater part of France the popular merrymakings whose commercial rôle is practically *nil* still bear the name of fairs.

While waiting for modern means of communication to penetrate to the corners of the country the "superannuated medium"[26] of the fair may, however, still find justification in turning from general to local trade. But even under this form it is condemned to disappear sooner or later except as it may survive by adaptation to certain specific categories of trade. Thus is transition made to specialty fairs.

Specialty Fairs

Certain decadent fairs long preserved a national or international rôle for certain forms of exchange. Some retained simply a financial function, liquidating accounts incurred elsewhere, as was the case with the vagrant fair of Besançon mentioned above: it was also one of the aspects of the fair of Leipzig in its period of decline, at least as regards the book trade. In other cases the degenerate fairs deal only with special articles of commerce produced or collected in their region; such were the ancient fairs of Caen in Normandy, which sold nothing but linen; those of Leipzig thirty years ago, which then specialized almost exclusively in furs and books. One might also mention the Polish fair of hops in Warsaw (September 13–17), the fish, oil, and down fair of Archangel, the fair of fats at Ischin in the government of Tobolsk. Specialty fairs can maintain themselves for a long time; in a quarter of Paris there is still held about Easter the "Old Iron Fair," or "Ham Fair," as it is also known from the featuring of that product in addition to old metal goods. The "Gingerbread Fair" is another popular old survival.

[26] "Intermédiaire suranné" according to the expression of M. Herriot (see footnote 43).

Specialization is particularly adapted to commerce in the rarer commodities for which there is a seasonal sale and which cannot be bought by sample. Furs, products of a typically nomadic occupation, offer a good instance in point. Until recently fur dealers frequented the Russian and Asiatic fairs, and such fairs as that of Irbit still do an important business in furs. Furthermore, the big fur markets of Europe and the newly established fur sales of New York and St. Louis[27] have the essential characteristics of the fair. In France a fair of small common furs is still held in the Jura towards the end of winter. Before the opening of the Suez Canal the teas of China, the commerce in which was related to the caravan trade in Central Asia, were largely sold at the Russian fairs, especially that of Nijni Novgorod. There is, however, one product which lends itself in a peculiar degree to the conditions of sale offered in the fair; this is live stock, and the stock fair still flourishes in western Europe.

Live-Stock Fairs

Many fairs that today deal only in cattle figured as commodity fairs two or three centuries ago. This fact is definitely known in certain instances; for example in France at Guibray (a suburb of Falaise) in Normandy, Autun, and Briançon.[28] Yet it must not be concluded that the present fair is a direct derivative of the old fair. In the instances cited the commodity fair with a more extended sphere of influence and greater variety and historic prestige has simply masked the contemporary existence of the cattle fair, though the latter in fact is probably still more ancient. This appears to be true as a general rule. Though the two forms may coexist they pertain to two different orders of conditions and, as will be shown, are fundamentally distinct.[29] There appear to be cases where in the same town at the same epoch separate cattle fairs and merchandise fairs have been held at different dates. Thus at Grenoble there is today an amusement fair held twice a year, for fifteen days each at Easter and in August, which twenty years ago was a little commodity fair. A cattle fair is held in the same town but in a different location and on different occasions. No trace of any connection between these two kinds of fairs is to be seen today. In the twelfth-century fairs of Champagne there was held once a year along with the general commodity fair a live-stock fair specially devoted to cattle, horses, and mules. In the archives of ancient Dauphiné the writer discovered that in Bourg d'Oisans between Grenoble and Briançon on the road to Italy there were held at fixed times every year about the end of the Middle Ages a general commodity fair and a local live-stock fair.

Town and Country Markets and Live-Stock Fairs

Primitive rural industry sells its surplus products intermittently, for the countryman who is occupied the greater part of his time on the land has

[27] See note on "Recent Growth of the Fur Trade in the United States," *Geogr. Rev.*, Vol. 5, 1918, p. 145.
[28] Petiot, *op. cit.*
[29] J. G. Bulliot: La foire de Bibracte, *Mémoires Soc. Éduenne*, Vol. 7 (N. S.), 1878, pp. 1–82. Autun.

little time to devote to commercial transactions. By its nature, too, agricultural exploitation imposes intermittency on commercial gatherings, which for reasons of convenience are most often made periodic. The rôle of the fairs of Kiev in rural commerce has already been cited. Where a sedentary agricultural population is concerned, these gatherings can be held at frequent intervals; the interval will be modified if an element of pastoral nomadism is introduced. Thus according to the progression of the seasons and the movements of the herds these gatherings attain a particular importance at certain seasons of the year. The best field for the present study of this phenomenon is furnished by the Islamic countries, notably of northern Africa where, as Jules Blache has recently shown, sedentary agriculture and pastoral nomadism[30] almost everywhere exist side by side. There the places where the country folk foregather bear the names of the days of the week and in succession provide for all the countryside.

Such rural gatherings, at the beginning held almost always in the open country, tend to become fixed centers of habitation. It is a commonplace that one of the reasons determining urban settlement is the concentration of agricultural exchange in the form of a "country market." But, in the measure that the town thus created develops, it begins to acquire its own proper functions. It ends by itself absorbing all the country products for which it has been the seat of exchange. Thus arises the city market without which the city cannot live. Zola gives us the study of a formidable contemporary example in "Le Ventre de Paris." Each city is surrounded by an area more or less extensive whose activities are almost exclusively devoted to supplying its sustenance, a fundamental element in any study of urban geography.[31]

Under the form of the city market rural commerce has only the most distant connection with fairs. In most of the towns of Europe markets and fairs are entirely separate and distinct phenomena, though, as we have remarked, they have a community of origin in the periodic gathering for the disposal of surplus agricultural produce. The market is closely bound to the town which it serves; the fair has only relations of tradition or convenience; it does not function for the town's sake, only for the surrounding country.

The distinction that we make would perhaps seem to be factitious did there not exist examples of the initial juxtaposition of market and cattle fairs in the same town and before their dissociation. There is the instance of the majority of the Islamic towns where, as we have said, the introduction of live stock at certain dates—which constitutes the fair properly speaking—heightens the activity of the market. Best of all is this demonstrated in ancient Rome.[32] There from the earliest times were held periodic country markets, *nundinae*, so called because held every nine days. The *nundinae*

[30] Jules Blache: Modes of Life in the Moroccan Countryside: Interpretations of Aerial Photographs, *Geogr. Rev.*, Vol. 11, 1921, pp. 477–502.

[31] Cf. Raoul Blanchard: Grenoble: Étude de géographie urbaine, 2nd edit., Paris, 1912.

[32] At Rome there were besides the *nundinae* fairs (*mercatus*) properly so called which were held biennially. They were associated with religious festivals; but their importance was completely eclipsed by that of the *nundinae*, which in fact really usurped the rôles of the cattle fairs and commodity fairs. (Huvelin, *op. cit.*, pp. 82–99.)

not only provided a sustenance market for the city; they also acted as the center of the cattle trade of Latium. The regulation of the market, its special juridical features, its locus in the city where each class of merchandise was sold in its proper quarter[33] are all features containing in germ the geographical characteristics of the live-stock fair as we shall analyze it later. As in the cattle fairs, there was added a minor trade in various small wares; and this at certain epochs seems to have developed into a veritable little commodity fair. In the Middle Ages, in fact, the term *nundinae* was currently used to designate the fairs for the sale of both merchandise and cattle;

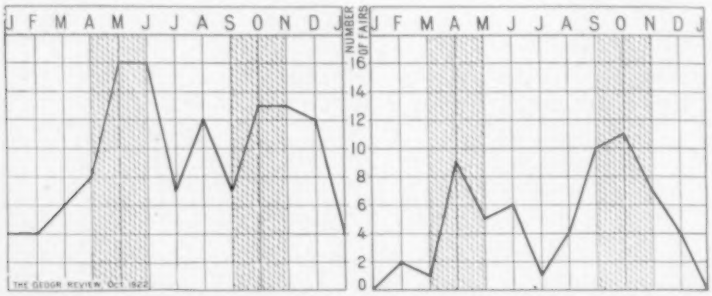

FIG. 6—Graphs showing the rhythm of country fairs in two regions of the western Alps; on the left in the *département* of Isère (from data by A. Allix), on the right in the region of Pinerolo, Italy (from data by G. B. Roletto). Months when the herds are moved to and from the upland pastures are shown by shading.

it was more frequently employed than *feriae*. The Roman *nundinae*, then, were a kind of combination of the three commercial institutions, the market, the cattle fair, and the commodity fair.

CONNECTION BETWEEN THE STOCK FAIRS AND PASTORAL LIFE

The pastoral industry is of all forms of exploitation of the earth that which most imperiously exacts movement from place to place, that is to say nomadism. Now it is exceptional that nomadism is purely capricious. Almost everywhere it takes place within definite limits, more or less extensive, and brings the herds and their guardians to definite places at fixed times. There are in Central Asia and the Sahara examples of pastoral nomadism of very long period, in the mathematical sense; in Europe today the periods, the distances, the forms even of this nomadism are infinitely varied; but it always exists in more or less definite form.[34]

[33] The division into commercial quarters or *suks*, under diverse forms is classic in the towns of the Middle Ages and today in the towns of Islam. At Rome there was the *forum boarium*, the *forum pecuarium*, *suarium*, *pistorium*, *vinarium*, *olitorium*, *piscatorium*, *cuppedinarium*, etc. Compare the localization in the commodity fairs and in the cattle fairs and sample fairs of today (discussed below).

[34] For various local examples in various countries see André Fribourg: La transhumance en Espagne, *Ann. de Géogr.*, Vol. 19, 1910, pp. 231–244; Philippe Arbos: La vie pastorale dans les Alpes Françaises, Grenoble and Paris, 1922; René Musset: The Geographical Characteristics of Western France, *Geogr. Rev.*, Vol. 12, 1922, pp. 84–99. From this point of view a special interest attaches to the last work cited, for it instances, in a non-mountainous region and under present-day conditions, the migrations of live stock to great distances in response to present physical necessities as much as to custom.

Without exception the rhythm of pastoral nomadism is governed by the rhythm of the seasons. The manner of adaptation to the seasons varies, but it is always nature which commands. Pastoral movements are much more rigorously controlled than those commodity movements of which we have spoken under commodity fairs. For the one it is a simple convenience, for the other a necessity.

In pastoral nomadism the fair appears as an element of permanence. Accustomed to pass at fixed intervals in the neighborhood of the same points, the driver of a herd knows that he will meet there drivers of neighboring herds. The meeting provides a temporary arrest of nomadism. It permits the exchange of animals, the making of contracts for the engagement of herdsmen, for the combination and composition of the herds, and for the sale of pastoral produce. Thither come also those people from the exterior who wish to buy cattle. The cattle fair is the rendezvous for the butchers of the towns, sedentary cultivators who wish to lease cattle, cattle dealers. For the industry of the pastoral region it is the sole commercial outlet; and for the exterior the sole economic contact with the pastoral region. For the pastoral people it is, furthermore, the opportunity to buy other products of which they have need. It is for this reason that the cattle fair is almost always accompanied by the sale of a certain amount of general merchandise and is attended by a host of itinerant retail traders. Sometimes these are merchants with an established place of business who take advantage of a near-by fair, but most often they devote themselves solely to itinerant trade,

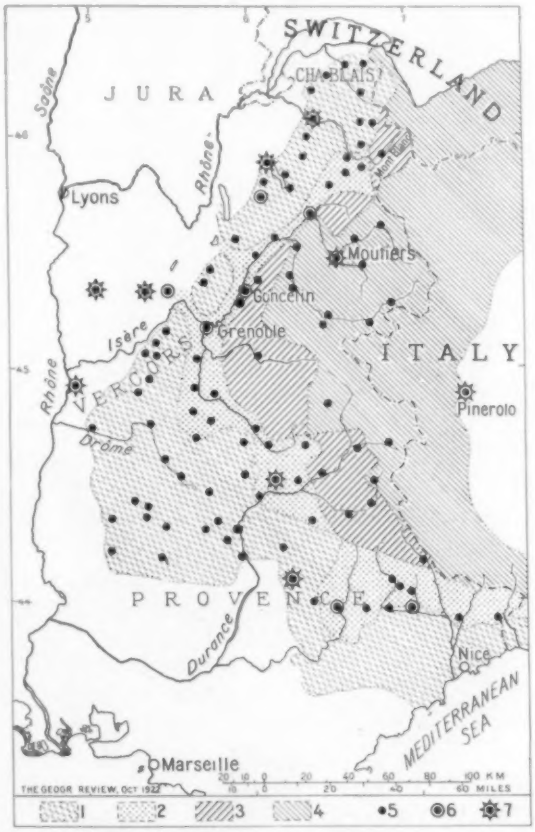

FIG. 7—Live-stock fairs of the French Alps (chiefly after Ph. Arbos). The numbers have reference: 1–4, natural regions; 1, pre-Alps; 2, sub-alpine depression; 3, central massifs; 4, intra-alpine zone; 5, fairs; 6, especially important fairs; 7, the great fairs exporting outside the Alps.

passing continually from one fair to another over the entire region. In this humble form alone does the cattle fair resemble the commodity fair and exceptionally is a degenerate derivative from it. Between the rhythm of the fairs and that of pastoral nomadism is an indissoluble connection. An attempt to change the traditional dates of fairs at the time of the French Revolution had quickly to be abandoned. However, in some non-mountainous regions where pastoral nomadism does not exist today there are fairs without apparent seasonal connection. For example in the Garonne basin fairs are generally held once a month. But even here the Spring and Autumn fairs if not more numerous are far more important as far as live stock is concerned.

Live-Stock Fairs in the Western Alps

It is from the western Alps that we shall select some present-day examples of live-stock fairs. It is true that this region is not the only one in the Old World where the institution keeps its importance nor even that where it is most widely developed or most generally known, but it is here perhaps that pastoral nomadism is most characteristically defined and presents the clearest relations with the mechanism of the fairs (Fig. 7). Furthermore it is the only one in which the requisite geographic studies have been carried out in detail. The following discussion will be in essence a résumé from three recent works—on the pastoral life of the French Alps as a whole by Philippe Arbos,[35] on the French fair of Goncelin by the author of the present article,[36] and on the Italian fair of Pinerolo by G. B. Roletto.[37]

We have already remarked on the close connection between the monthly frequency of the live-stock fairs and the movements of the herds (Fig. 6). In the winter the stabled animals are fed on hay gathered during the preceding season. For the cattle industry this was long a dead season during which the animals were merely kept alive and from which they emerged in great need of fattening on fresh pastures. Great progress has been made in recent years, however, in stall feeding; and it is not uncommon for animals at the end of the winter to be ready for immediate sale. It is in regions where this stall feeding is practiced that the fairs are held the earliest—even before Easter.

In spring the herds are made up to go to the "mountain" or "alp" for the warm season—a business for which the fairs are an almost indispensable medium since the owners must place in common keeping their beasts and their interests. In general this is the period when fairs are most numerous. In the southern section of the Alps, the sheep country, where spring is earlier, the time of the greatest number of fairs is April; in the northern Alps, the cow country, it is May and June.

While the herds are summering on the mountain—"les montagnes sont garnies"—there is a diminution in the number of fairs, especially in the sheep

[35] See footnote 34.
[36] See footnote 24.
[37] Le condizioni geografiche delle fiere di Pinerolo, *La Geografia*, Vol. 9, 1921, pp. 99–135.

FIG. 8

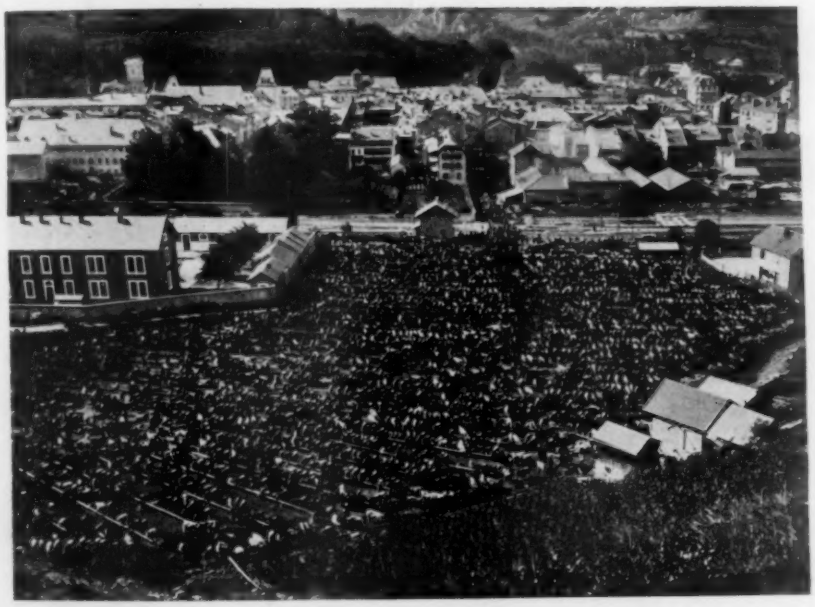

FIG. 9

FIG. 8—The live-stock fair of Autun, Central Massif. (Photograph by courtesy of E. Guignard.)
FIG. 9—The September live-stock fair of Montiers-en-Tarentaise, Savoie. (Photograph by Raoul Blanchard, reproduced from Fig. 27, in Ph. Arbos: La vie pastorale dans les Alpes françaises.)

country. In the cow country summer fairs are held for the sale of dairy produce, the chief agricultural wealth of the Alps. Sale of cheeses is the more necessary as that product is the common currency with which communes or individual proprietors are paid the rent of the mountain pasturages.

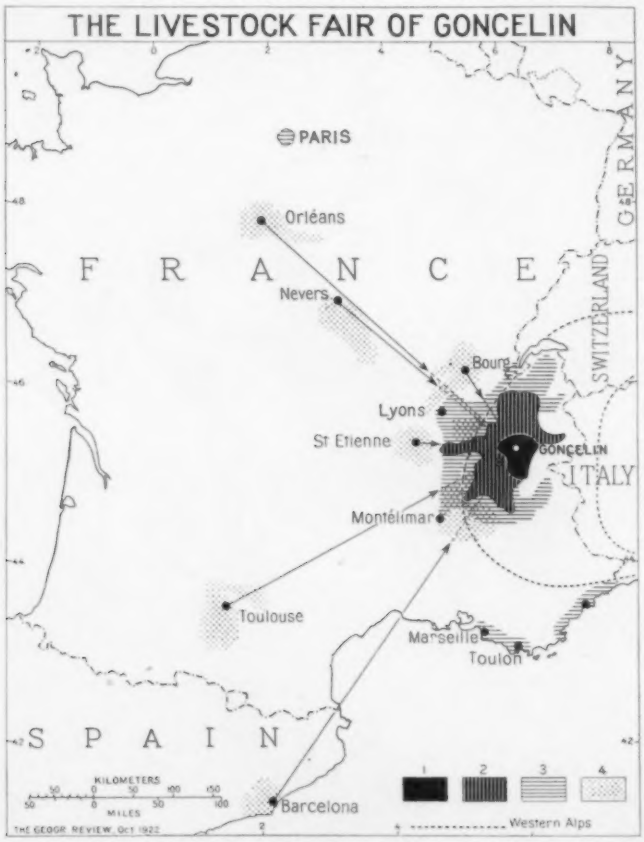

FIG. 10—The economic sphere of the live-stock fair of Goncelin. The numbers have reference: 1, economic domain, or *umland* of the fair; 2 and 3, regions supplied by the fair with cattle and sheep—2, regions regularly supplied by direct exportation (the circle herein is Grenoble); 3, regions supplied irregularly and by the intermediary of other fairs (re-exportation); 4, regions supplying the fair's import of pigs.

In autumn, sometimes from the end of August, the beasts begin to descend well-conditioned for slaughter; it is again a period when fairs are particularly numerous for the pastoral folks then wish to liquidate the expenses of the summer period and realize their profits. The fairs of this season are in general the most important of the year. At the big Savoyard fair of Moutiers-en-Tarentaise, for example, some 4,000 to 6,000 head of cattle are

assembled each September (Fig. 9). The season terminates in October or November in the warmer regions of the south by some big sheep fairs before the period of winter stabling is begun or the winter migration of sheep takes place towards the sunnier regions of Provence.

Figure 7 shows all the centers of the French Alps where live-stock fairs are held at least four times a year or where they have a recognized importance. It will be noted that they are ranged in the largest number among the chief highways traced by nature and the roads leading to the great Alpine passes; then in the natural regions[38] whose own products play an accessory part in the trade of the fairs (the rich agricultural country of the sub-alpine depression; and Vercors and Chablais, regions producing breeds suitable for the mountain); then the great valleys of the intra-alpine zone, the country *par excellence* of summer pasture outside the Alps. In all these regions the herds still travel on the hoof for the most part, the railroad is only used for exportation outside the Alps. In this respect the entire country of the French Alps presents the characteristics of an economic unit.

Two Examples in Detail: The Fairs of Goncelin and Pinerolo.

The great fair of Gresivaudan, held at Goncelin probably from the end of the Middle Ages, is the pastoral center of a little economic domain in the interior of the French Alps. We say advisedly the fair and not the town of Goncelin; for the town has no connection with the pastoral business other than to give asylum eighteen times a year to the gathering of stock raisers and their beasts, the cattle dealers, and the itinerant retail merchants. The fair is held every Saturday in May and June, on the 10th and the 25th of August, and again every Saturday in November and December. In regard to its economic domain the rôle of the fair is triple. First it centralizes the exchanges made in the interior. The beasts here pass from one owner to another, and here are drawn up contracts for summering and for rent of the mountain pastures. In the second place, the fair concentrates the animals destined for exportation outside the region. And thirdly, and this aspect is perhaps a little unexpected, it is a medium of importation for the region. There is, in fact, one kind of live stock that the region does not raise but which it consumes in quantity, that is the pig. Every countryman fattens one or two pigs for home consumption, but he buys the animals young at the fair, and should he have more than he needs he sells his surplus there. This rôle of importer and exporter is analogous to that played by a port in respect of its *hinterland;* and it was this fact that led the author in 1914 to propose the term *umland* to designate the economic domain of the fair.[39]

We now turn to the fair of Pinerolo, of which M. Roletto has given us an

[38] See Raoul Blanchard: The Natural Regions of the French Alps, *Geogr. Rev.*, Vol. 11, 1921, pp. 31–49.

[39] M. Roletto (*op. cit.*, p. 134) does not see the necessity for this new term and prefers "economic domain," which, however, is not only longer but less precise; *umland* has specific reference to the commercial balance of exchange with the exterior and with it is associated the idea of "land" port.

excellent picture in his thoroughgoing study. Pinerolo is situated where one of the most important systems of converging valleys of the Piedmontese Alps opens on to the plain. One of these valleys, the Val Cluson, is the age-old route from the Piedmont to Dauphiné by the pass of Mont Genèvre, and Pinerolo was up to the nineteenth century a point of departure and arrival of international traffic. Towards the mountains the *umland* of the fair is limited by the French frontier and by the crest defining the confluent valleys. On the plain, where there is neither natural barrier nor international boundary, delimitation is less clear; and here the commercial attraction of the great center of Turin makes itself felt in constantly increasing degree.

The fair of Pinerolo, like that of Goncelin, dates from the end of the Middle Ages: its charter was granted in 1433, and it was held for the first time in 1450. It has, however, suffered changes in which may be traced political and economic influences. At the beginning exclusively pastoral, it was held in April and November—spring and autumn fairs of standard type. Later boundary changes increased the sphere of the fair (the change of 1713 was to Italy's advantage; further north, in 1860, a change was made to the prôfit of France) and led to improvements in the agricultural production of the region, especially on the Piedmont plain; and growth of industry in the town of Pinerolo contributed to its progress. In the nineteenth century the date of the autumn fair was progressively advanced until it ended by being held in August. Today the dates of the fair are the last Monday, Tuesday, and Wednesday in April; the last Tuesday and Wednesday in August. By a coincidence which is relatively rare the August fair corresponds to the festival of the patron saint of the region. The fair today has a mixed character, agricultural and pastoral, but trade in live stock is dominant. Grains—wheat and maize—are also commercially important; but—and this shows the fundamentally pastoral character of the fair—they are sold at the weekly market with its more limited scope rather than at the fair where the important sales are in cattle, horses, mules, and pigs.

For cattle the fair of Pinerolo plays the part that we have already described in the case of the Goncelin fair; it brings together the stock of the region, regulates the local nomadism, and furnishes export material. The greatest buyer is Turin. For other kinds of stock it functions rather as an importer, for there is no breeding center in the region. Here its sphere extends to the Abruzzi, to Touraine, and to Hungary (Fig. 11). In addition it has a more important rôle as a distributing agent than Goncelin. The pigs imported, like those of Goncelin, are distributed throughout the economic domain; but these limits are considerably passed in the case of horses and mules, in fact it may be said that the entire upper basin of the Po obtains from the fair of Pinerolo its requirement in these animals, the horse for the plains, the mule for the mountains. The spring fair of Pinerolo is perhaps the most important mule fair in northern Italy. Even for cattle the rôle of the fair of Pinerolo appears to surpass that of Goncelin. Within its economic

sphere are other local fairs which effect a preliminary concentration of the cattle destined for sale outside the region. These are then brought to Pinerolo where they are bought by outside dealers who thus are saved the trouble of visiting the local fairs. Pinerolo might be described as a fair of second (or superior) degree, a characteristic which M. Roletto has not pointed out, though it appears to the writer a distinguishing feature. In the French Alps there are several great fairs of the same kind, which collect for

FIG. 11—Map showing the sphere of influence of the fair of Pinerolo, Italian Alps (after G. B. Roltteo). The area of the Alps is approximately indicated by shading; the economic domain of the fair is shown in solid black; the numbered lines show origin of (1) pigs, (2) horses, (3) mules brought to the fair from without the economic domain.

export from the local fairs and are frequented by dealers who supply every section of France.

PRESENT-DAY DECLINE OF THE STOCK FAIRS

At the present time we are witnessing a somewhat rapid transformation of pastoral industry in the Old World. The rhythm of nomadism, while yet respected, is no longer of vital importance. The stable is no more a temporary makeshift but a place for the fattening of stock for the market. In some places the summering on the mountains has been given up altogether, as, for instance, in the humid massifs of the pre-Alps where around each village is plenty of grass for the entire year. Transhumance of the flocks of sheep from Provence to the Alps and vice versa is also on the decline. At the same time the fair whose *raison d'être* is pastoral nomadism is progressively losing its age-old importance.

Live stock has gained in value, is more sought after, and at greater distances and more regularly. The phenomenon is general, but it is very clearly apparent in the French Alps where the introduction of modern means of communication has been relatively late and abrupt. A more extensive

clientele demands a more regular supply, which the system of fairs, essentially intermittent, does not furnish. Purchases are made daily. The fairs, it is true, are sufficiently numerous and uniformly distributed over the entire area of the pastoral country to guarantee at least one at every season of the year, but their inequality in magnitude is unsatisfactory to the dealers; only the big fairs of spring and autumn are adequate in this respect, and at these the competition between buyers is more and more keen.

There is, furthermore, a constantly increasing tendency for the buyers of pastoral products, both stock and dairy produce, to travel the mountains at all seasons and purchase direct from the producers. Live stock and dairy produce bought in such way travel at all seasons by road and rail. As the countryfolk say, trade is done less and less at the fair and more and more "on the road." The buyers seek to get ahead of one another and strive in particular to obtain the best of the stock some days before the fairs. Hence the fairs tend to be neglected both by buyers and producers. There are entire regions where this commercial vehicle, but lately important, has now fallen into complete disuse; as, for instance, is the case with Trièves to the south of Grenoble.[40]

Decline is overtaking the stock fairs of the Old World as it has overtaken the merchandise fairs, but more slowly and more recently. Must one conclude, then, that they too will sooner or later fall into complete decadence? We do not think so. It must be recalled that cattle are bought individually rather than in the bulk. Undoubtedly if buying is done by the entire herd, as is commonly practiced in the New World, direct control at the moment of purchase is as little necessary as in the buying of corn by the sack or coal by carload. But in Europe stock-buying is seldom done this way. Even if reduced to a secondary commercial rôle, the cattle fair must long survive as affording the best way of inspecting all the cattle of a region with a view to purchase. Furthermore, the stock raiser is not a professional trader, as is the cattle dealer, and can give only a limited portion of his time to the business of buying and selling; he will always have need of the fair to meet his neighbors and examine their beasts, and inter-regional exchanges will always be made there for the greater part. The opportunity for intercourse is an important function of some fairs of today; as the people say, one sees there "many people and few beasts."

The diminished element in the fair is the commercial specialist who, carrying on his business over a great area and varying it according to the interest of the moment, escapes the local geographic limitations. Yet it must be observed that he does it only at a price—by constant travel, fatigue, and additional expense. In contrast the stock fairs offer a positive convenience, and it is not impossible that they will survive, at all events for trade in cattle and beasts of burden, because of the economy they effect in movement and effort.

[40] Charles Robequain: Le Trièves: Étude géographique, *Rev. de Géogr. Alpine*, Vol. 10, 1922, pp. 5–126 Grenoble.

It is an attempt to realize a precisely similar economy in trade in general merchandise that has led to the revival of the old system of commodity fairs under the form of sample fairs. The success of this enterprise shows that it corresponds to a real commercial utility, and it is this same utility that, in conjunction with the permanence of geographic factors discussed above, leads the writer to believe if not in the future growth at least in the persistence of the stock fair.

The Sample Fairs

Origin: The Fair of Leipzig[41]

During the course of the nineteenth century the fair of Leipzig entered on a progressive decline. Towards the end of the century it had become almost entirely specialized in furs and books, with the trade in these tending to desert the fair and become established in permanent quarters in the town. It also had to enter into competition with other fairs of powerful scope held at Berlin.

About 1897 there was taken in the history of the Leipzig fair, and in consequence in the history of international fairs in general, a decisive evolutionary step from which there arose a type of commercial organ adapted to modern life. It was—and the fact is sufficiently rare in geography to merit note—the result of deliberate human initiative, the actual creation of a permanent new fact.

The new tendencies of the Leipzig fair made a tentative appearance in 1890 and were elaborated to definite form in the succeeding six or seven years. The object was to preserve the wholesale trade of the fair and prevent degeneration into a local retail fair, as had happened to its former contemporaries and rivals. Manifestly the old system was incompatible with direct sales in bulk; and the idea of sale with immediate delivery was abandoned. The goods themselves were not brought to the fair; the old-time warehouse of the fair disappeared. Visitors and buyers were offered only *samples* of merchandise; orders were taken to be executed at contracted times; merchandise was dispatched from seller to buyer without passing through the fair. The fair then took on the aspect of an exchange for commercial orders, though temporary and periodic. Broadly advertised, it was also able to draw together interests from a very wide area.

By the circumstances from which it arose the new fair of Leipzig was at the beginning closely connected with the economic life of its immediate surroundings. It called for the exhibition of manufacturers' samples, and the only manufacturers who were directly interested in establishing the new system at Leipzig were those of which the town was the commercial center—Saxony, Thuringia, and Franconia. It was the manufacturers of these three

[41] Léon Arqué: La foire de Leipzig à l'époque actuelle, *La Science Sociale*, June, 1910, pp. 13–96. Paris. Die Technische Messe, Leipzig, 1921. Charles Touzot: Une visite à la foire de Leipzig, automne, 1921 (unpublished archives of the Lyons fair). Personal information. See footnote 43.

regions who at the beginning founded the union of merchants directing the fair, *Verband der Messkaufhäuser*, an association in which the Saxons (but not the people of Leipzig) naturally dominated. These regions produced a variety of products; the metallurgical products of the Erzgebirge, the mechanical constructions, textiles, and industrial products of Chemnitz, Zwickau, and Plauen; the glass and scientific apparatus of Jena; the hardware, edged tools, and light hardware of Franconia and Saxony; the innumerable

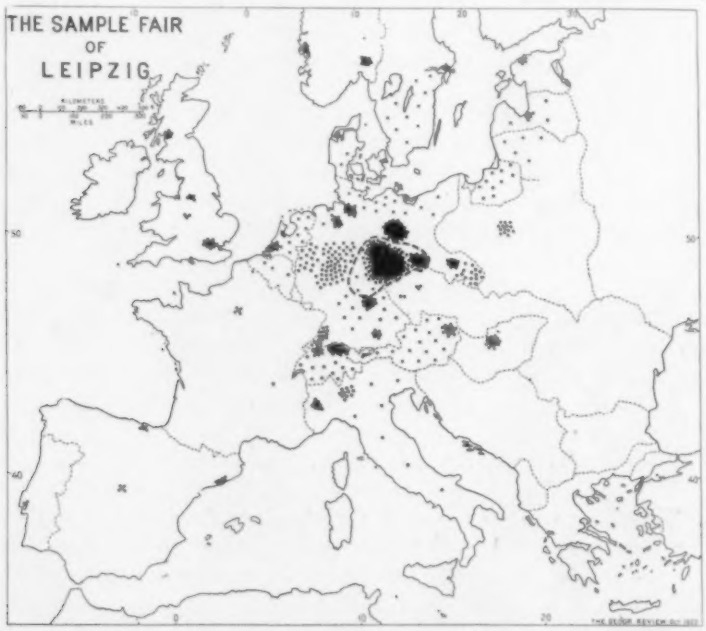

FIG. 12—The economic sphere of the sample fair of Leipzig. The heavy broken line shows the economic domain of the sample fair in its earlier years (1897–1917). Dots represent the point of origin of participants in the fair, each dot representing an average of 5 participants (1914–1922).

wooden products of Thuringia and the Saxon mountains; the basketry, papier-maché, blown glass, and porcelain of Thuringia, etc. Such are the wares that for twenty years have been offered in sample form at the new fair of Leipzig. It must be emphasized that the fair has played its rôle for a limited and well-defined geographical domain (Fig. 12). We may compare it in this respect with the live-stock fairs. Here is a veritable *umland* especially concerned with export, which business the fair facilitates as the fairs of the western Alps facilitate the exportation of cattle. The prime character of the German fair of the Middle Ages is thus reversed; the sample fair of Leipzig is *Ausfuhrmesse*—a fair of exportation, but for a limited *umland*. It should be understood, however, that while this definition is true at present it is not

final and does not exclude the possibilities of development in other directions. Even now it seems that the exhibition of merchandise produced from other more distant regions is an aid to the provisioning of the *umland* with its requirements. And there are indications that a possible function of importation will complete the character of the fair, which will thus conform closely to the definition that we have offered—a sort of inland port[42] satisfying the import and export needs of its *umland*.

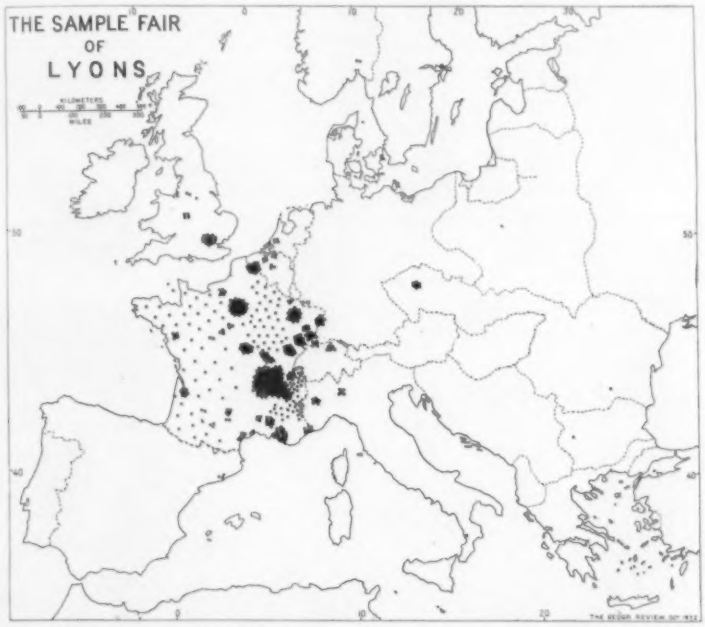

FIG. 13—The economic sphere of the sample fair of Lyons. Dots represent the point of origin of participants in the fair (spring and autumn), each dot representing an average of 5 participants.

However, the *umland* is not everything in the sample fair. It functions for a much broader terrain. From the beginning of the twentieth century, and especially since 1917 when the activities of the new fair of Lyons began to be manifested, that of Leipzig extended its influence to include the whole of Germany. Products from Westphalia appeared, and first the cheap cutlery of Solingen and the cheap jewelry of Pforzheim; then the products of the industries of Silesia and of Berlin, comprising altogether an infinite variety of manufactures in metal, wood, rubber, and chemical goods. For a long time foodstuffs, textiles, raw materials, and colonial products were not admitted to the fair, but they finally made their appearance during the war. In virtue of its character the fair is specially interested in placing new goods

[42] Arqué (*op. cit.*) expressly compared the fair to an "inland port."

on the market as speedily as possible. This is most peculiarly true of articles that vary according to the mode, and during the war was also the case with innumerable substitutes, *Ersätze*, chiefly in textiles and foodstuffs. Thus the fair became more complex, including all categories of goods and drawing producers and customers from all the territory of the Central Powers. At the beginning of the war and in view of the importance of the fair the *Verband* sought to have it recognized as an activity of the Empire with the participation of the German State, and this was realized at the end of the war. Nothing shows better the special importance of the fair of Leipzig—which in 1915 was attended by more than 20,000 exhibitors and buyers—and also the utility of this new vehicle in the complex commercial life of today.

Before leaving this analysis of the new fair of Leipzig we may recapitulate its basic characteristics. It is held at fixed times, towards Easter and at Michaelmas (end of September). It has a fair ground and special buildings in the center of the town, though the greater number of the exhibitors install themselves with their exhibits in rented chambers and apartments. Yet the fair is not part of the town. The *Verband* controls it, organizes publicity and propaganda, and enters into arrangements with transportation companies and hotels for the concession of special terms. Under a modern form these are the traits which we have seen in the old commodity fairs. One can even see the suggestion of a revival of the old "conduct of the fair" in the tickets, or certificates, issued to participants in the fair granting special advantages. During the war these tickets served, especially for foreigners, as veritable "safe-conducts." Again it may be compared with the *suks* in the localization on the ground of the various products exhibited; and foreigners, Swiss, Swedes, Dutch, etc., have their clubs and clubhouses which recall the old *fonduks*.

It is true that the chamber of commerce and the municipality play an important part in the administration of the fair, and it is evident that the town benefits from it and is interested in seeing it prosper. But we must again insist on the separation of the two things, the fair and the town. There is no absolute geographic bond between them. The fair lives for itself. Tradition, the skill of the directors, good organization, and especially the address that evolved the new form are the real reasons for the actual location of the fair. At the time of the fair the activity of the town is intensified, concerts and entertainments naturally gain with the increased population and are then most brilliant. Streets are decorated, processions parade the town, bands at their head; but, let us note, under this appearance of festivity it is always the interests of the fair and the fair alone that are considered. All these parades and merrymakings have but one object—publicity for such and such products offered at the fair. Trade in the town benefits by the influx of sightseers; but the administration of the fair is properly concerned with limiting their numbers; its interest here is just precisely contrary to that of the town. Only accredited business men are permitted to visit the

fair, and to do so they must show a badge for which they pay 20 marks—one of the sources of revenue of the fair.

The New Fair of Lyons

The second great sample fair of Europe which is considerably younger than that of Leipzig was directly inspired by it. The Lyons fair had its inception in a suggestion made in 1915 and promptly taken up and put into effect by M. Édouard Herriot, mayor of the city.[43] The first sample fair of Lyons was held March 1, 1916, with the intention of making it an annual

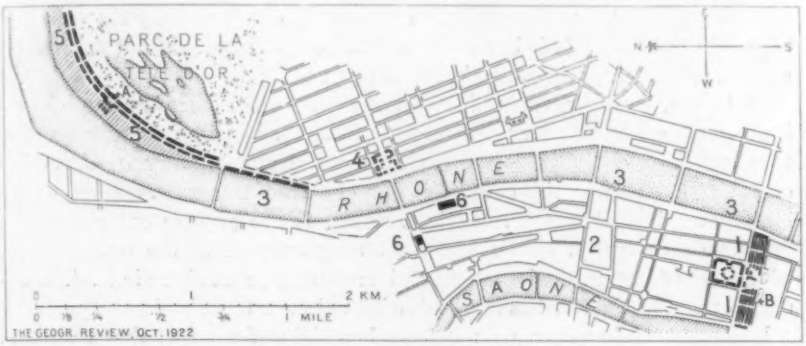

Fig. 14—Lyons, a part of the town and the sample fair. Numbers have reference as follows: 1 and 4, temporary wooden structures erected on public squares; 2, square occupied by a part of the fair in 1919; 3, quays occupied by a part of the fair in 1916, 1917, and 1918; 5, future fair palace—solid black showing part constructed in 1921; shaded, the part to be constructed from 1921 to 1930; 6, the permanent offices and exhibition of the fair. *A* indicates the viewpoint of the photograph Figure 16; *B*, that of Figure 15.

event. Such was the rapidity of its development, however, that from the beginning of 1919 it was necessary to make it a biennial event, and it is now held March 15 and October 15. Its success is manifested in the figures of the financial transactions accomplished therein; 95,000,000 francs in 1916; 410,000,000 in 1917; 1,035,000,000 in 1919; 953,000,000 in 1920. All kinds of merchandise are accepted under sample form. It may be noted, however, that the category of exhibitors is confined to direct producers and exceptionally to importers and wholesale merchants, unlike the Leipzig fair, which admits all classes of middlemen. Thus is explained the difference in the figures of participants for a commercial importance sensibly the same.

In 1918[44] the classes of merchandise sold through the medium of the fair were, in order of value, out of a total of 750,000,000 francs: cotton goods

[43] Édouard Herriot: Une offensive économique, la foire d'échantillons de Lyon, *Rev. des Deux Mondes*, Vol. 32, 1916, pp. 758–787; René Hoffherr: La politique d'une foire d'échantillons: La foire de Lyon, Lyons, 1922; C. Germain de Montauzan: La foire d'échantillons, Lyons and St. Étienne, 1918; *Bull. Mensuel de la Foire de Lyon* (before 1920), *Lyon*, (since 1920). Archives of the fair and personal information. Special acknowledgment must be made to M. Charles Touzot, general secretary of the Fair, author of many articles in the above-mentioned publications and unpublished material, and to his collaborator, M. René Hoffherr.

[44] Étienne Fougère: La foire de 1918, *Bull. de la Foire*, p. 12, Lyons, 1918.

80,000,000; automobiles and cycles, 70,000,000; agricultural implements, 56,000,000; machinery, 50,000,000. Then followed electrical apparatus, metallurgical goods, leather goods, industrial construction materials, hardware, chemical products, boots and shoes, stationery, food products, colonial products, paper, ready-made clothing, furniture, hosiery, heating apparatus, skins and furs, silks (only 10,000,000), watches and clocks, toys, building materials, pottery, woolen goods, and lastly corsets and haberdashery (5,000,000). Amongst the diversity one notes the relatively small showing made by the products of the industrial region of Lyons proper; silks in particular, although this product is peculiarly adapted to such a form of sale. The reason is simple enough; the silk merchants of the town do not take the trouble to exhibit at the fair when they can benefit by the arrival of buyers in the town. It is but another instance of the permanent and fundamental unlikeness of interests between town and fair.

At Lyons, however, this unlikeness of interests is reduced to a minimum because the committee for the direction of the fair is exclusively composed of townspeople and the initiative came from the municipality itself, as five centuries before was the case with our old commodity fairs of which we flatter ourselves this is a revival. The fair is the private enterprise of a joint-stock company, but it has the strong support of the municipality, which indeed appears to be taking an increasingly great share in it. The administration of the fair has its headquarters in the town hall.

With all this, however, we must not lose sight of the fact that town and fair are distinct. To the average tourist they will probably appear more distinct than at Leipzig. Lyons is much less crowded and disturbed by the fair than is the German center. Of course there is greater animation than usual; the streets are illuminated at night, hotels and places of entertainment are filled, and the shopkeepers of the town show special displays; but there are no parades nor particular festivities, and the daily routine of the town is not sensibly changed. The gathering is exclusively a business affair and only frequented by business men. For this reason a good part of the fair, unlike that of Leipzig, does not occupy town buildings but has its own installations either temporary or permanent within or near the town. The only exceptions are two permanent services—the administration and a permanent exposition. The greater part of the fair is installed in temporary wooden structures erected twice a year on the public squares and the extensive quays along the banks of the Rhone. The number of these erections, however, is diminishing; and they will eventually be replaced by a stone building now in the course of erection on a great open space of common land outside the town. It is expected that this building will be completed in ten years and it is believed in Lyons that it will be the largest in the world. It will cover an area of 1,200 meters by 50 meters and will be four stories high. It is planned to include 64 separate pavilions connected by continuous galleries and comprising 1,360 exhibition stands, accommodations for the participants of the fair, rooms for meetings and conferences, restaurants, postal

FIG. 15

FIG. 16

FIG. 15—The sample fair of Lyons in 1921, temporary buildings on the public squares of the town. Compare Figure 14.

FIG. 16—A portion of the fair palace of Lyons, 2 of the 64 pavilions under construction. Compare Figure 14.

80,000,000; automobiles and cycles, 70,000,000; agricultural implements, 56,000,000; machinery, 50,000,000. Then followed electrical apparatus, metallurgical goods, leather goods, industrial construction materials, hardware, chemical products, boots and shoes, stationery, food products, colonial products, paper, ready-made clothing, furniture, hosiery, heating apparatus, skins and furs, silks (only 10,000,000), watches and clocks, toys, building materials, pottery, woolen goods, and lastly corsets and haberdashery (5,000,000). Amongst the diversity one notes the relatively small showing made by the products of the industrial region of Lyons proper; silks in particular, although this product is peculiarly adapted to such a form of sale. The reason is simple enough; the silk merchants of the town do not take the trouble to exhibit at the fair when they can benefit by the arrival of buyers in the town. It is but another instance of the permanent and fundamental unlikeness of interests between town and fair.

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and telegraph offices; and it already has railroad connection and a station of its own. Thus buyers and sellers at the fair can sojourn there and transact their business *without once setting foot in the town*. The fair palace will be a complete town in itself, adjacent to Lyons but living only twice a year for a fortnight each time. This typical independent organization of the fair shows the essential features of its kind, elsewhere only completely realized at Nijni Novgorod. But Leipzig also is constructing permanent fair buildings and dreams of the erection of a great edifice, a skyscraper thirty stories high with 3,000 stands and 22 elevators. Nothing demonstrates better the fundamental distinction between fair and town that we have pointed out as characteristic from the earliest beginnings of the institution.

We cannot leave the fair of Lyons without briefly remarking on its sphere of economic influence. If silk makes a poor showing, other industries of the town are well represented—automobiles, chemical goods, shoes, and certain food stuffs. But the greater number of the products pertain to the surrounding industrial region and to southeastern France in general—the agricultural implements of the Saône valley, the electrical industries of the Alps, the machinery and tools of lower Dauphiné, of the northern Jura and Belfort and the Central Massif, especially St. Étienne and its neighborhood. The *umland* of the fair is clearly defined (Fig. 13), and it is a buyer as well as a seller; it gives the fair its complete rôle of an organ adapted to import as well as local export. The sphere of the fair, however, tends to stretch beyond this limited area to embrace the whole of France and even to pass the French frontiers. Only in the measure that one goes farther away from the town are other influences felt, and it is not the only sample fair frequented. Competitors are encountered in foreign countries, and even in France its domain is limited by the newer and more specialized fairs of Paris and Bordeaux. Yet it embraces a number of exterior relations that recall the activities of the great commodity fairs of ancient days. In November, 1921, it had agencies, private consulates as it were, in Brussels, Geneva, Prague, Milan, Rotterdam, Sarrebrück, London, Stockholm, Christiania, Seville, Constantinople, New York, Buenos Aires, Rio de Janeiro, and Peking. Its directors see in it not only a means of encouraging the French export trade and a system of intellectual propaganda,[45] but a place of contact and collaboration between traders from the four corners of the world. They seek to establish twice a year at Lyons a center for commercial information, for international credit, and especially an international clearing house for goods or money. And so by a circuit across the centuries we return to one of the most striking traits of the old commodity fairs.[46]

As yet, however, the rôle of the Lyons fair is predominantly national.

[45] This function recalls that of the ancient fairs of Lyons in the sixteenth century. They were the great center of the French book trade, as later those of Leipzig were for Germany. The printers of the town arranged publication for the time of the fairs. Caravans from the Mediterranean countries, especially Spain, after having sold their merchandise took books as return cargo. It has been repeatedly shown that the great fairs were an excellent means of diffusion of knowledge. See Alengry, *op. cit.*

[46] An instance of this international collaboration at the fairs is the fact that at the spring fair of 1921 the International Labor Bureau had a stand at Lyons.

Above all, during the war it rendered great service by making known French products, replacing those erstwhile obtained from Germany, an inverse form of the *Ersätze* of the Leipzig fair. It also served in equalizing the inequalities of supply and demand during the abnormal war and postwar periods.

Other Examples of the Sample Fair[47]

The advantages offered by the sample fair have proved such that during the last five years several have been created in imitation of those of Leipzig

Fig. 17—Map showing distribution of the chief sample fairs of Europe in 1921.

and Lyons. Figure 14 shows the distribution of the principal sample fairs of Europe up to November, 1921. The oldest, after the two examples we have discussed above, is that of London, which dates from the spring of 1916. We shall say nothing of the geographic circumstances governing the location of these fairs, for this has already been developed apropos of the commodity fairs. It may be remarked that the majority of the new fairs have been organized like that of Lyons, with the specific intention of encouraging export from the home country. Each economic power has instituted one, sometimes several; in the latter event they may become competitive—a contingency that has been feared in the case of the three French fairs. They can, how-

[47] J. J. Martin: Les foires françaises et étrangères, in "Semaine du commerce extérieur," *Assn. Natl. d'Expansion Econ.*, Paris, 1921, pp. 208–221.

ever, act in collaboration; and this is the case with the three fairs of Great Britain which are held in such a way that the stranger can visit the three in a single trip.

As a consequence of each country having its own fair and seeking its own interests in competition with those of its neighbors, the respective *umlands* tend to coincide with the limits of the states; and hence they tend to be national in their normal function. They are international only for special reasons and now and then. The present tariff situation in Europe tends to frustrate growth of the international character that distinguished the ancient fairs. But if there is any institution that can ultimately transcend this barrier and reanimate international trade it would seem to be the fair with the various customs, fiscal, and transit privileges that lie within its power to secure.[48] We recognize in the sample fairs, as in the commodity fairs, the initial needs of frontier trade which, with the necessity for mobility, is the actual creator of the institution.

Other Kinds of Fairs

There also exist other phenomena of commercial geography which are more or less related to the sample fairs and which are sometimes known as "fairs." Such are exhibitions known as "world fairs"—a term that came into universal use from the World's Columbian Exposition of Chicago in 1893. The idea of the world fair dates back to that inaugurated by the Society of Arts in London in 1851 and held under the presidency of the Prince Consort. It was quickly followed by like international exhibitions at New York and Dublin in 1853, Melbourne and Munich in 1854, Paris in 1855, and subsequently by many other well-known examples.[49] These, however, do not pass beyond what may be described as the advertisement stage and cannot properly be considered fairs, for they carry no mechanism for sale nor financial organization. The participants, for instance, charge their expenses to the publicity budget, while the participants of the fairs charge it against their sales accounts.[50] Exhibitions have only the superficial appearance of the real fair, from which even in that respect they are vastly different in the number of side shows and attractions for sightseers, sedulously avoided in the business fairs. On the other hand, the initial idea of the sample fair is approached in the fair of Kiev, discussed above under commodity fairs, which for half a century has made sales on order.

Other commercial events that approach more closely the sample fairs and which might even be included in that category are the annual motor and

[48] In illustration we may quote from a note in *U. S. Commerce Reports*, August 22, 1916, on "Lyon's Second Sample Fair:" "The French Government on May 11, 1916, issued a decree prohibiting the importation of certain goods, and this prohibition is so extensive that it threatens to materially affect the importations from the United States. However, the mayor of Lyon, who is also a senator [deputy since 1919], has advised me of his success in obtaining a modification of this decree in so far as it applies to orders taken at the fair."

[49] See the article "Exhibition" in the Encyclopaedia Britannica, in which is also traced the history of the earlier national exhibitions.

[50] Ch. Tougot in *Lyon*, October, 1920.

cycle shows for the last twenty years held annually in London and Paris (since 1920 Paris has added an aeronautic show); they have been established expressly from the sales point of view and exclusively by sample. They may be considered rudimentary or, rather, specialized fairs as so many merchandise fairs became in their decline. They seem to indicate that under certain conditions specialization is necessarily forced on the sample fair and suggest that that may be a line of evolution followed in the future.

Finally, there is a new form of the sample fair to which indeed the strict constructionist would refuse the name of fair [51] but which is permissible according to our definition and is so described by the commercial world. These are either intermittent or itinerant fairs.[52] As we have seen above, there exist non-periodic commodity fairs. Similarly fairs have been recently organized under the form of expositions of samples with a sales organization attached but without intention of periodicity. Such were the fairs of Fez in 1916 and Rabat in 1917. These enterprises are most commonly organized in a foreign country with the object of soliciting a market. It was for this purpose that French business organizations arranged the "French fair of Stockholm" in 1920. Various countries, of which Great Britain was the first, have conceived the idea of sample fairs which travel to foreign countries and take up orders. Such a project in grandiose form is evidently only realizable by sea: in England it is one of the activities of the "Department of Overseas Trade" (Joint Department of the Foreign Office and the Board of Trade) established in 1917. The Netherlands, Italy, and Russia have circulated "floating fairs" on a small scale. France has given to the idea a more restrained form in her "sample trains," following a plan which had been devised in Russia in 1895 to compensate the inconveniences caused by the enormous distances in the Russian Empire. In 1920 a French train fair traveled through North America, notably in Canada. These ambulant fairs depart from the normal institution in that as yet they are purely national in character, officially designed as economic propaganda, that they have reference only to exportation, and above all in that they are not a place of rendezvous and of periodic contact between neighboring peoples. We shall, however, class them as fairs inasmuch as they possess to a supreme degree the basic geographical trait that they are itinerant commercial organisms.

Conclusion

As the aim of the preceding discussion has been to portray the fundamental resemblance in the several kinds of fairs under the variety of forms they display, the discussion has inevitably assumed the character of a somewhat formal and abstract analysis: an intensely living and moving subject has perforce been reduced to dry categories. We should now like to see produced a number of monographs describing in detail this particular manifestation of

[51] See footnote 21.
[52] J. J. Martin, *op. cit.*

human activity in all its picturesque complexity; for among its multitudinous aspects it would be quite possible to disengage those of enduring value and geographical bearing.

Definition of the Fair

It remains for us to give a geographic definition of the institution of the "fair." A tentative definition was advanced by the writer in 1914,[53] but a recent discussion has put in question his formula.[54] The definition of 1914 read "*a parasitic town, existing intermittently, periodically superposed upon a permanent town*, for the needs of the import and export trade of an *umland*." M. Roletto rejects as uncalled-for the neologism *umland;* but, as we have shown above, it possesses a more precise connotation than "economic domain." On the other hand, study of the fair, especially the merchandise fair, shows that its function often exceeds the needs of its *umland*[55] and hence that this word is not indispensable to the definition. We shall then modify it by substituting for the last phrase "*for the needs of itinerant commerce of a region in its entirety*."

M. Roletto denies the fair the right to the title of "town," because, he says, of its lack of habitations. But fairs with habitations are in fact more numerous than others; and the two cases of Goncelin and Pinerolo, analyzed above, are rather exceptional. Every one is familiar with the hawker's "caravan;" we have made reference to the accommodations provided in the fair buildings of Nijni Novgorod and Lyons and by the *fonduks* of medieval times and of the Islamic countries at the present day; and even when the fair invades the town, as at Leipzig, it loans dwellings for its own proper, if temporary, use. We maintain, then, our conception of the fair as a town, but an intermittent town, sometimes even, in part or whole, a nomad town. In a recent novel the term "wandering city" (*l'errante cité*)[56] was aptly applied in description of a pleasure fair: it is the moving city, or the city of itinerants. M. Roletto also rejects the idea of parasitism and substitutes that of coexistence. But parasitism here carries no derogatory sense but is the translation, rational and geographic, of the idea of coexistence. The fair temporarily invades a town and occupies it for purposes alien to the life of the town while benefiting from its geographical position and site and, obviously, from its facilities for support. Surely it has the significance of the ordinary technical meaning, where the uninvited organism makes its home with its host, but with the difference that the fair is frequently chosen by its host. M. Roletto has good reason to speak apropos of the fair of the *agglomeramento ospite;* it seems to us that he there gives expression to a new and useful idea—"host town," as we should render it in English, *ville-hôtesse* in French, and *Wirthstadt* in German. It is, with the *umland*, one of

[53] *Op. cit.*, p. 333.
[54] Roletto, *op. cit.*, pp. 133–134.
[55] *Ibid.* M. Roletto shows it perfectly for the live-stock fair of Pinerolo.
[56] Jacques Chardonne: L'Épithalame, Paris, 1921, Vol. 1, p. 3.

the fundamental elements in the definition of every fair. Finally, in a formula inspired by the preceding but expressly limited by him to the particular case of Pinerolo, M. Roletto declares that the intermittent institution of the fair has been "created to satisfy the local and extra-local needs of a commerce specifically determined by the geographic conditions of the *host town*."[57] Our analysis, however, has shown that in general the rôle of the host town is much more limited; normally it is even more limited than that of the *umland*, since in the same region the sites of fairs can be changed while the business of the fairs remains unchanged. Therefore we maintain our definition as given above.

Rather is it the geographic conditions of the region that play the important part. Needs of commerce in primitive countries, exigencies of caravan transport, age-old wanderings of the herds in pastoral lands, present-day circulation of merchants in search of customers—all these movements expressive of human activity are in the fair temporarily but conveniently enough brought together. Shorn of the accessory facts that make its picturesque diversity, the fair is the expression of the needs of men constrained by nomad life to meeting and trafficking at intervals. It plays the same rôle in itinerant life as the town plays in sedentary life.

[57] ". . . "creato per soddisfare alle esigenze locali ed extralocali di un commercio voluto specialmente dalle condizioni geografiche dell' agglomeramento ospite" (p. 134).

SOME UNUSUAL EROSION FEATURES IN THE LOESS OF CHINA

By Myron L. Fuller

The general characteristics of the landscape of the yellow earth region of northern China are well known. The deep sunk valleys and deep worn roads, the vertical walls with their excavated dwellings, the natural terraces perforce figure in any description of "loess land." It is here proposed to discuss some of the minor forms exhibited by the loess.

Natural Loess Bridges

Of the several striking forms resulting from loess erosion none is more conspicuous than the natural bridge. In general aspect (Fig. 1) the natural bridge of the loess closely resembles the familiar limestone bridge. The span of the arches seldom exceeds half the height of the opening: broad spans, such as those of the sandstone arches of Utah, are naturally unknown in a material which is unconsolidated, uncemented, and of limited cohesion.

Loess bridges are natural in their mode of formation, although certain artificial conditions, such as artificial terracing, may favor their development. They are invariably found near some abrupt change of slope, as along the rim of a ravine or canyon-cut plateau, near the edge of a flood plain, or on the interrupted slopes of terraced hillsides. A few have also been developed in the divides between headward-advancing ravines, whose upper ends are approaching each other.

The loess bridges, because of the limited cohesion of their material, are necessarily short-lived as compared with limestone and sandstone bridges; but weathering and erosion features associated with them seem to point to ages measured by hundreds of years, if not occasionally a thousand. They never span flowing streams but are limited to gullies in which water flows only after fairly heavy showers.

Loess Bridges on Plateau Rims

Loess bridges occur most commonly on plateau rims. They are found where the waters of the flat or gently sloping upland surfaces find downward passage along the vertical joint, cleavage, or other structural planes of the loess, to relatively porous bedding planes, thence laterally to adjoining ravines. The passages, through combined spalling, caving, solution, and mechanical dissolution of the walls, become rapidly enlarged into vertical pipes or wells connecting with, or merging into, horizontal or

downward sloping tubes. Figure 2 is a view taken from the inside of such a tube, in this instance some three feet in width and ten feet in height, looking outward toward the valley into which it drains.

The next step in the process is the formation of other pipes and tubes along the line of drainage in the rear of the first (these later caving to form an open gully) or the eating back of the loess by the normal process of gullying. In the meantime the covering above the tubes is reduced, while

FIG. 1—Loess bridge spanning the mouth of a ravine.

FIG. 2—Looking outward from a loess tube connecting loess well or sink with valley.

the tubes are enlarged until, in the end, natural bridges alone remain spanning the gullies, which may lead backward into the uplands as open cuts half a mile to a mile or more above the arch. Figure 1 shows a good example of this type of bridge. A smooth, grassy remnant of the plateau constitutes the top. On the sides, at the level at which the man is standing, are shelves marking a former position of the floor beneath the arch, now cut to a depth of five to eight feet by a sharp V-shaped notch, as a result of the rejuvenation of erosion. The breadth of the arch is about 15 feet and its height about 35 feet above the bottom of the notch. The opposite hills rise to heights of 300 to 500 feet and are entirely of loess. The characteristic jointing, which so facilitates the penetration of water, is seen on the right.

LOESS BRIDGES ON TERRACED SLOPES

The artificial terracing of valley sides as an aid to cultivation presents conditions particularly favorable to the formation of loess bridges. The

normal run-off is checked both by the flat steps and by the raised rims which enclose the terraces on the outer sides, with the result that the water has a more than ordinary tendency to follow the perpendicular plains downward into the loess and thus to the formation of vertical pipes and connecting tubes and, eventually, the development of natural bridges as out-

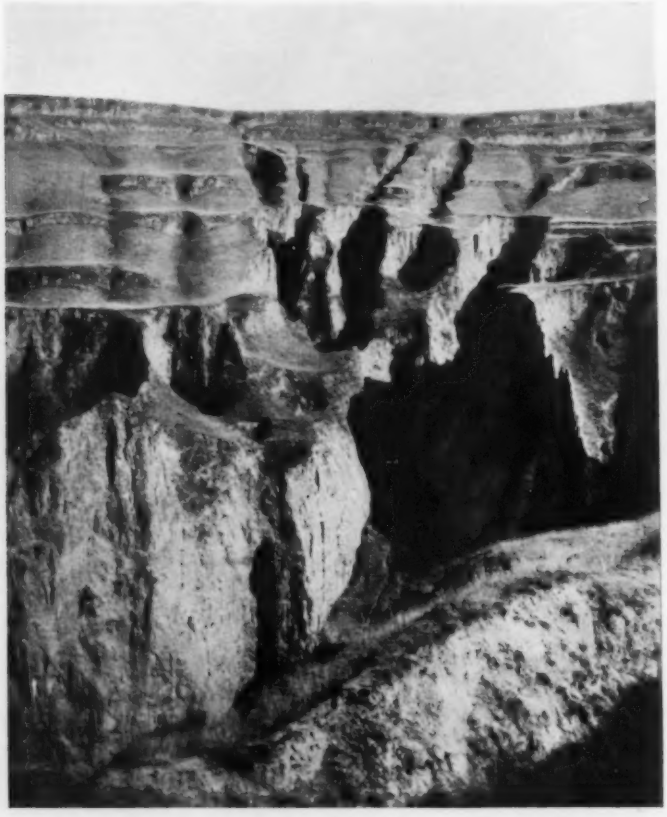

FIG. 3—Loess pipes, tubes, wells, and sinks on terraced slope.

lined above. Figure 3 shows the earlier stages of bridge formation on a terraced slope. In the foreground is the mouth of a tube, similar to that of Figure 2, draining the two small pipes immediately above as well as the larger loess well in the rear. In the center, to the right and somewhat above the foregoing, is an older, much enlarged, irregular well draining outward under a bridge into the ravine within the dark shadow on the right. Above this big well or sink, in turn, entering it beneath bridges in shadow, are three open gullies leading back to the edge of the plateau. As in the case

of the plateau bridges, the water movements concerned take place far above the normal ground-water level. Details of the subterranean erosion of the loess are more fully discussed in the section on loess wells.

Loess Bridges Along Streams

The bridges along streams are not formed above the water table, as were the bridges previously described, but are the result of normal ground-water movements, through which parts of the loess are mechanically removed and borne to the stream toward which the waters drain. The result of this undermining is a series of jagged gash-like sinks, often paralleling the river for some distance, as shown in Figure 4. In the walls between the gashes and the streams a number of loess windows and bridges are usually found; but they are short-lived, the walls soon crumbling by the mechanical erosion of the supporting loess. No instance of the formation of a bridge by normal undercutting was observed.

Fig. 4—Loess gash sinks paralleling a stream.

Bridges of Flood Plains and Divides

In the loess regions of China the flood plains of the streams are mainly composed of eroded, transported, and redeposited loess, which, in the absence of sand, gravel, or organic material (the latter rare under the existing arid conditions) is indistinguishable from wind-deposited loess. The wet-weather drainage across such flood plains has occasionally produced bridges of six to ten feet in span and ten to fifteen feet in height, under conditions essentially similar to those described above.

When two complexly branching and opposing stream systems cut backward in the thick loess, it is inevitable that individual gullies will occasionally head against one another. In many cases where the erosion has been rapid, the gullies terminate in vertical walls. Under such conditions the bottoms may be cut through while the tops are still preserved, leaving natural bridges of varying span and height.

Distribution of Loess Bridges

Loess bridges are characteristic of youthful stages of erosion and are limited, so far as the writer's observations go, to those regions where there

FIG. 5

FIG. 6

FIGS. 5 and 6—Loess dikes between the heads of opposing streams. Both examples occur on important routes and show evidence of artificial maintenance.

has been increased erosion following recent rejuvenation. This rejuvenation may be due to the supposed recent deforesting of the loess area by man, to an increase in average rainfall, or to differential elevation of the loess area. The first cause is regarded by the writer as doubtful in most cases. The last, which is borne out by many features of the loess topography itself, as well as by certain features of the rock valleys of the Hwang Ho and tributary

FIG. 7—Loess dike forming the divide between two streams eroding unequally—one (to the left) rapidly, the other (right) slowly.

streams, is regarded as the most probable cause of the accelerated erosion and the formation of the loess bridges. The examples illustrated are all on tributaries of the Hwang Ho in eastern Shensi.

Loess Dikes or Wall Divides[1]

The traveler in the more deeply dissected portions of the loess is certain to retain vivid impressions of the dizzy heights of the narrow, vertical-sided dikes which constitute the wall-like divides between the heads of opposing ravines.

The dikes are usually fairly straight,[2] but a few are curved or even

[1] The name wall divide has been suggested by W. M. Davis and D. W. Johnson.

[2] Compare the illustration, Figure 4, of F. G. Clapp: The Hwang Ho, Yellow River, *Geogr. Rev.*, Vol. 12, 1922, p. 8. Several photographs have been loaned for use in this paper by F. G. Clapp.

sinuous (Fig. 5). Their faces, in the central portions at least, are nearly or quite vertical and from 50 to several hundred feet in height. Connecting the plateau levels on either side, they form natural passageways which have been utilized by the Chinese from time immemorial in their travel on foot or mule. They are seldom over ten feet in width, often no more than five feet, and the views of the depths below from the backs of horses or mules are found by many disturbing if not actually terrifying. Indeed, even the natives often dismount on the narrow dikes and sometimes actually crawl across on hands and knees. Nor is the danger entirely imaginary, for after protracted rainless seasons the loess becomes exceedingly dry and considerable masses not infrequently scale from the sides, sometimes precipitating mules and even men into the depths below. Some of the dikes traversed by the writer's associates in China had dwindled to a width of less than a foot and crumbled even as the mules passed. Since their use saves descents of many hundreds of feet into the precipitous ravines and heartbreaking climbs back to the plateau levels on the opposite sides, they are never abandoned as long as a mule can scramble across.

While the sides of the dikes are characteristically vertical, their attitude is really dependent upon the rapidity of backward erosion. Where the streams on either side of the divide are eating back slowly, the walls may not have angles of more than 45°. When one is eroding slowly and the other more rapidly, the walls may be respectively sloping and vertical, as on the right and left sides of Figure 7. With rapid erosion on both sides, each wall is vertical.

The lengths of the narrow portions vary from a few rods to several hundred feet, but the approaches are often over narrow spurs of much greater length (Fig. 5).

Formation of the Dikes

The primary causes leading to the formation of loess dikes are definite and simple, being normal headwater stream erosion acting on a soft material with vertical jointing or at least a marked tendency toward vertical scaling.

Why the dikes are so long and so straight is not so clear. The straightness and smoothness of the sides often give an appearance of artificiality, but in only a few instances was any actual evidence of the hand of man recognized. The most conspicuous examples of artifically maintained dikes are shown in Figures 5 and 6, the first on an important trail near Chung Pu,[2] the second on the main cart road of north Shensi near Lo Chwan. The smooth sides of both give unmistakable evidences of human workmanship. Figure 7, on the other hand, shows a dike which appears to be untouched by man. In the case of one or two of the smaller dikes it was observed that brush had been placed to retard the wash.

[2] See the map "The Great Wall of China," *Geogr. Review*, Vol. 9, 1920, opposite p. 268.

It is evident in many instances that the opposing ravines, having cut back to within a few feet of one another, begin to broaden out on both sides, instead of cutting through the narrow separating walls. The high, narrow dikes may indeed remain while gullies are cut back laterally, perhaps for hundreds of feet. The prevailing straightness of the dikes suggests a relation between their form and the use to which they have been put by man. Possibly the compacting of the tops under the feet of travelers, who commonly outnumber the mules or donkeys, makes the surface more

FIG. 8—Erosion pinnacle in normal loess.

FIG. 9—Turret pinnacle in aqueous loess and gravel.

resistant to the penetration of rain and scaling, or the lateral ditching along lines later followed by side gullying may aid in determining the form of the dike. Both suggestions seem far-fetched, but the fact remains that the erosion actually takes place as described and leaves the long, straight, high divide walls or dikes.

Loess Pinnacles

Loess pinnacles, standing as detached tower-like or needle-like masses, are not uncommon features of loess erosion in China. In origin the loess pinnacles may be either wholly natural or the result of a combination of natural and artificial conditions. They may take the shape of turrets, spires, sharp cones, thin, finlike masses, or of combinations of two or more of these forms. The material is usually pure loess but may be a mixture of sand and gravel with reworked (aqueous) loess.

Turret Pinnacles

Flat-topped turrets of pure loess are rare, for the reason that the caps of such pinnacles, consisting of loess which has lost its normal cohesion through its conversion into soil and the penetration of rootlets, do not long preserve their vertical faces but rapidly scale away at the sides until their terminations become mere points. Such an example is illustrated in Figure 8, which shows a pinnacle about 40 feet in height and 13 feet in diameter. A pinnacle of this form may be regarded as transitional between turret and spire. The true turret form is shown by the gravel and loess pinnacle of Figure 9.

The turret pinnacle is practically always the result of normal natural processes of erosion. In the majority of instances, the loess masses first become detached as a result of the differential retreat toward one another of the vertical loess walls of the V-shaped points between valleys joining at acute angles. The severed bodies that result are triangular, rounded, or irregular in outline and may be of considerable size. They suffer slow reduction mainly by the spalling of slabs from their vertical faces. Sharply projecting points not infrequently become severed from irregular loess cliffs and by the same process are converted into turret pinnacles, or again they result from the reduction of masses detached by cut-offs of broadly swinging streams; but these last are not common.

Spire and Needle Pinnacles

Spire and needle pinnacles have the general form shown in Figure 8, but they are more slender and needle-like, with diameters only a small fraction of their heights. In 8,000 miles of traverse only a few were seen, and these under conditions which did not permit them to be photographed. An idea of the form of such needles or spires may be gained by imagining the left portion of the pinnacle of Figure 8 to be split away along the line of separation already seen to be developing, leaving the slender right section standing alone. Such pinnacles are usually not over twenty or twenty-five feet in height and three to five in diameter. They are probably most frequently the result of the scaling of masses from cliffs. The beginning of the separation of such a spire is shown on the right side of the loess canyon of Figure 10. Since this separation is the result of movements of the detached portions themselves rather than the removal of material in their rear, there must be a certain crushing or movement of the material of their own bases which largely destroys the natural coherency of the loess. For this reason, the spires produced by this type of spalling are weak and short-lived.

Conical Pinnacles

The conical pinnacle is a steep-sided, usually slightly blunted, cone of loess having a height from one to two times its diameter. An example is

shown in Figure 11 which has an approximate height of 50 feet and a diameter of 30 feet, a size above the average, for the majority of the forms that may properly be regarded as pinnacles do not exceed 30 feet in height or 20 feet in diameter. Conical pinnacles result from the same natural processes as in the case of the turret pinnacles and also in considerable number from partly artificial conditions. The soft loess of the roads and trails is churned up by the wheels of carts or the hoofs of mules until a bed of loose dust six inches to a foot or more deep is formed. This is either picked up by the wind and whirled away or washed out to some near-by valley by rain. Sometimes several inches is removed during a single storm.

FIG. 10—Beginning of separation of spire pinnacle from loess cliff.

and the road or trail gradually becomes a miniature canyon. Many are now 50 feet in depth, and some 75 to 100 feet or more, though most are abandoned before reaching the latter depth. In a large number of instances new roads are started close to the rims of the old ones, and, as they in turn are worn down, parallel canyons, separated by thin loess walls, result. By the natural processes of scaling and spalling, the walls are slowly broken down and a series of cones, spires, or fin pinnacles remains to mark the points where they were thickest. The conical pinnacles thus formed, many of which mark roads abandoned hundreds or even a thousand years ago, far outnumber those formed by purely natural erosion. Figure 11 shows two residual pinnacles of this origin. In this instance, three lines of former road at two levels are involved, while as many others skirt the rims outside the limits of the picture, which shows one of the oldest roads of Central China, possibly dating back to 2000 B. C. There is reason to believe that

many of the loess-canyon systems, although now showing no trace of roads, had their inception in the wear and wash of ancient highways.

Fin Pinnacles

The fin pinnacle is a tall, thin, elongated, flat-sided mass of loess with notched crest, suggesting in its general form the dorsal fin of a fish. The central mass of Figure 12 represents a pinnacle of this type. The height is 40 or 50 feet, and the thickness five or ten feet. Fin pinnacles are rarely the result of normal erosion. It is conceivable that under especially favorable conditions they may originate between two closely adjacent streams or at the necks of oxbows, but no examples of either were noted. The great majority of those seen represented broken-down partings between ancient double roads.

Another important class is that formed by a similar process along the rims of cliffs. In those parts of China where the intense struggle for a living compels the utilization of every possible inch of tillable land, the upland roads and trails are crowded, wherever possible, to the very edge of the cliffs bounding the plateau remnants. As such roadways become worn down, narrow loess walls remain between them and the cliff faces and in the process of gradual reduction give rise to numerous fin pinnacles.

Distribution of Pinnacles

The pinnacles do not seem to be limited to any particular locality, providing the loess sheet is of sufficient thickness to permit their development, and they may be looked for anywhere in the great loess area lying between the Mongolian, or Gobi, Desert on the north and the mountains of southern Shensi on the south, and between the Coastal Plain on the east and undetermined limits in western Kansu or beyond. There seems to be a more marked tendency toward the formation of pinnacles in comparatively humid Shensi and Honan than in the more arid Kansu. Few were seen in Shansi, possibly because of the comparative thinness of the general loess sheet, partly because of less sharply developed erosion and the prevalence of more gentle slopes, and partly owing to the greater precautions taken against gullying on the part of the more numerous inhabitants.

Loess Wells

A loess well is a circular hole of varying size and depth closely resembling in appearance an ordinary well dug for water before it has been stoned up (Fig. 13). The usual diameter of the wells seen was eight or ten feet, but occasional diameters as small as five feet or as great as 20 feet were noted. The wells were never less than 15 feet in depth and seldom more than 30 feet. The walls were vertical for practically the entire depth. Bottoms were cup-shaped or irregular and usually deeper on the far side with refer-

FIG. 11

FIG. 12

FIGS. 11 and 12—Loess pinnacles left by the erosion of ancient parallel roads. Figure 11 shows a conical, Figure 12 a fin pinnacle.

ence to the direction of ground-water movement. In some instances openings a foot or two in diameter, occasionally larger, led away from the well in the same direction.

All the typical loess wells seen by the writer were in the eastern portion of the province of Kansu, about 600 miles southwest of Peking. None were encountered in Shansi or Shensi, although both provinces, which are deeply loess-covered, were crisscrossed from north to south and east to west by numerous traverses. Each of the latter provinces afforded, however, instances of irregular tubes and gashes apparently of the same origin as the circular wells, and it is to be supposed that wells also occur.

The loess wells always occur on flat upland surfaces of the general loess plateau not far removed from gullies, ravines, canyons, or deep valleys where walls are vertical or at least very steep. Probably few wells are found more than 150 feet from the plateau rim, while most are within 100 feet of it. They are not associated with surface depressions but are formed on flat surfaces like that shown in Figure 14.

The loess wells are clearly of the nature of sinks, but they result primarily from settling consequent upon the mechanical removal of underlying material rather than from its removal by chemical action as in ordinary limestone sinks. Their inception seems to result from seepage movements, sometimes along bedded layers, which, although differences are indistinguishable to the eye, are, nevertheless, more porous than the surrounding material; but more frequently they result from water movements along irregular channels leading diagonally downward through the loess toward an adjacent ravine or valley at angles of 30°, 45°, or even 60°. They are entirely above, and unconnected with, either normal or perched ground-water tables and represent simply the lines of least resistance to percolating waters.

The water movement along such lines probably results in some solution of the calcareous particles of the loess but leads first to increased porosity rather than to open passages. Soon, however, the openings along the line of movement become large enough to permit the mechanical transportation of the finer particles of the loess; and more or less tubular channels, analogous to those giving rise to the springs of clays and glacial tills, are formed. Eventually, by the caving of roof and walls, these may reach diameters of a foot or more. Wherever, along such passages, the well-known tendency of the loess to vertical cleavage happens to be most strongly developed, caving from the roof will begin on a more conspicuous scale. Downward percolation of waters from the surface furthers the process, and perpendicular cylindrical cavities will be extended upward, finally reaching the surface and giving typical loess wells.

In dry times the drainage passages tend to close by spalling or caving but they are reopened after heavy rains. By progressive enlargement the areas between the wells and the mouths of the outlet are undermined until, in the end, ravines heading at the wells replace the underground passages.

FIG. 13

FIG. 14

FIG. 13—Natural wells in loess on the plateau surface near a canyon rim.
FIG. 14—Typical loess plateau, near the rim of which the natural wells are developed.

In at least one instance a loess well has been known to result from the caving of an abandoned underground dwelling dug into the face of a cliff 30 feet or more below the surface in which the well was developed.

There is no definitely known cause of the limitation of the wells to the Kansu area. Possibly the reason lies in the more calcareous nature of the Kansu loess, which is nearer its source, Mongolia, and has been largely a direct deposit of the wind, while to the south and east water transportation intervened before the final distribution of the loess by winds. The greater rainfall in Shansi and Shensi may also favor the formation of large gashes and irregular cavities rather than the smaller and more symmetrical wells, while the latter, if formed, might be sooner destroyed by the more copious rainfall.

THE UNGUARDED BOUNDARY *

By JOHN W. DAVIS

Of the many artificial lines which the hand of man has traced on the habitable surface of the globe, certainly at the moment none exceeds in significant importance the one to which I beg to direct the attention of this distinguished audience. Bismarck is reported to have said that the most significant circumstance in current history was the fact that practically the whole of the North American continent speaks the English language. The meaning which he attached to that fact finds its symbolic expression in the location and history of the boundary line between the United States and Canada.

On a front of 5,400 miles, or, roughly, as far as from New York to Buenos Aires or Petrograd, or from London to Cape Town or Bombay, by land and water, over mountain and plain, through prairie and forest, the British Empire and the United States meet each other face to face, without thought of defense or fear of aggression. In all that distance the only sentinels that guard the line are the silent monuments erected by the joint action of the two nations; the only vessels are the unarmed ships which carry the commerce of their common waterways; the only weapons are the woodman's ax, the huntsman's rifle, and the tools of fruitful trade and agriculture. Peace reigns from end to end as profound and undisturbed as the quiet of the primeval forest that still clothes many reaches of the boundary line. It is a peace, moreover, not of monotony or of solitude, for a journey along the windings of this far-flung frontier is an epitome of the industrial and commercial life of the two countries.

THE CANADIAN-UNITED STATES BOUNDARY—ITS COURSE BRIEFLY TRACED

Let us consider the variety of scene and circumstance which such a journey would present. The traveler who would follow the boundary begins at a point in the Atlantic Ocean in the Grand Manan Channel, in latitude 44° 40′ and longitude 67° approximate, and enters the Bay of Fundy with its gigantic tides (25 feet at the entrance, 50 feet at the head), passing Quoddy Head, the most easterly point in the United States; thence through a narrow channel past the towns of Lubec and Eastport, busy with their herring fisheries, up the Passamaquoddy Bay and into the St. Croix River. This river he follows to its source up Monument Brook and thence 77 miles due north, through a rolling country famous for potatoes, to the middle of the St. John River. Ascending the main channel of the St. John he finds himself in a beautiful and fertile valley filled by French-

* An address delivered before the American Geographical Society on April 25, 1922.

speaking inhabitants and, having reached the St. Francis River, he pursues the devious windings of that forest stream to Lake Pohegamook, in latitude 47° 28′, longitude 69° 15′; still in the forest shadow, he reaches the St. John again and follows its southwest branch to the crest of the watershed dividing the waters of the Kennebec, Androscoggin, and Penobscot Rivers from the tributaries of the St. Lawrence. Clinging to this watershed, he encounters Hall's Stream and is guided by it to the 45th parallel of latitude, surveyed in 1774 by Valentine and Collins for the then British Governors of New York and Canada as the line between those provinces.

Westward then with the Valentine-Collins line, crossing Lake Memphremagog and the Richelieu River, the traveler comes to the old Indian village of St. Regis on the banks of the majestic St. Lawrence and, breasting the swift current of that powerful stream, follows it past hamlet and village and town, through the beautiful Thousand Islands with their hundreds of summer homes, until it enters Lake Ontario at Cape Vincent. Crossing Lake Ontario, the line runs up the Niagara River, dividing the great waterfall impartially into the American and Canadian Falls, and reaches the outlet of Lake Erie near the American city of Buffalo, a port whose commerce, inland though it be, compares with such ocean ports as Glasgow. Then to the west end of Lake Erie, up the Detroit River between the cities of Detroit, Michigan, and Windsor, Ontario; through Lake St. Clair to Lake Huron; over that lake to the Sault St. Marie with its great locks, which evil minds during the late war plotted to destroy, and out into the vast unsalted sea of Lake Superior. The voyager through the Great Lakes meets all along the way an unending stream of vessels bringing down the grain of the western wheat fields and the iron and copper of the Lake Superior basin and carrying back in return fuel and supplies for all the broad northwestern region.

The boundary leaves Lake Superior at the mouth of the Pigeon River, over the route taken in early days by the adventurous brigades of the fur-trading companies, and makes by South Fowl Lake, Lac La Croix, Rainy Lake, and the Rainy River to the northwesternmost point of the Lake of the Woods, where it turns due south twenty-six miles to an intersection with the 49th parallel of latitude. Here uncertainty and deviation disappear. Regardless of obstacle it plunges to the west, across the swampy timbered country of the Roseau River, then over many miles of fertile and untimbered prairie to the Turtle Mountains, rising one thousand feet above the plain. Here are trees again, but after thirty-five miles of grateful shade the traveler descends to a semi-arid and treeless plain extending to the foothills of the Rocky Mountains with their forested slopes. The divide is crossed at an elevation of 7,300 feet; and after a succession of rivers and mountains, glaciers and lofty summits, much of the time through heavy timber, one comes to level country in approaching the sea and reaches salt water at the Gulf of Georgia; down the Gulf, though Haro Strait and Juan de Fuca Strait, and the end of the line is found in

the Pacific Ocean at latitude 48° 30′ and longitude 124° 40′, 3,900 miles from the point of departure.

The Alaskan-Canadian Boundary

There are, however, 1,500 miles still to traverse, which are by no means the least difficult of the journey. Five hundred miles north of the Strait of Fuca the Alaskan-Canadian boundary begins at Cape Muzon, the southernmost point of Prince of Wales Island. Crossing the sound known as Dixon Entrance, it follows the Portland Canal, so named by Vancouver, to its head near Mts. Gladstone and Johnson; then by straight lines drawn from peak to peak roughly following the windings of the coast, encountering the greatest glaciers in all the world outside the polar regions, and crossing the Unuk, Stikine, Whiting, and Taku Rivers, it mounts the White and Chilkoot Passes, over which the rush of gold seekers made their eager way into the Klondike, and pauses at the towering height of Mt. St. Elias, perhaps, with its 18,000 feet, the most magnificent boundary post in all the world. Two miles northeast of Mt. St. Elias the line reaches the 141st meridian and pursues it over barren mountain ridges, trackless glaciers, and fields of driven snow, passing the White, the mighty Yukon, and the Porcupine Rivers, to the Arctic Sea.

Historical Scenes Associated with These Borderlands

Many sorts and conditions of men are to be encountered in these 5,400 miles of travel, from the fishermen of the eastern coast to the gold hunters of the Yukon, and, whether among the woodsmen of Maine, the sailors and toilers of the Lakes, the herdsmen of the prairie, or the prospectors of the western mountains, one can find ample material for stories of adventure and romance. Still more thrilling would the recital be if one should turn the pages of history and read what it has to tell of the border in the days when discovery was new. Great names flash out like meteors from every page and deeds of daring as bold as ever poet has sung. Starting in the East, the story would take up the voyage of Sebastian Cabot to Newfoundland in 1497 and of the Frenchman, Cartier, to the St. Lawrence in 1534; the journeys and labors of Champlain and his winter with De Monte on the Isle de St. Croix; and, pressing further west, the discoveries of the indomitable La Salle on the Lakes and the Mississippi. It would tell of the settlements by the English, the Mayflower and Plymouth Rock, Sir William Alexander and his Scotch in Nova Scotia; and would go on to describe the long and bloody warfare between France and Great Britain for supremacy on the continent. Into the picture come the painted figures of the warlike Iroquois, the five confederate nations of Mohawks, Oneidas, Onondagas, Senecas, and Cayugas, who formed, with their 2,500 fighting men, perhaps the most effective barrier to the southward march of the French. And we should see the long contest terminated forever on the Heights of Abraham by Wolfe

and Montcalm, whose joint monument in the city of Quebec finely records that "fate gave them a common death, history a common fame, and posterity a common monument." Then the American Revolution arrives upon the scene; Ethan Allen and his "Green Mountain Boys" pounding at the gates of Fort Ticonderoga with their demand for its surrender "in the name of the Great Jehovah and the Continental Congress;" the loyalists of New England hurrying across the border to join their comrades in Nova Scotia and the North; while Montgomery makes his ill-starred effort to repeat the successes of Wolfe against Quebec.

No less moving, although the stage is filled perhaps by fewer figures, is the story of the Pacific, dating from the day when Balboa marched his men into the surf at Darien and proclaimed the sovereignty of Spain over the broad waters of the new sea "for all time, past, present, or to come, without contradiction . . . north and south . . . from the Pole Arctic to the Pole Antarctic." Up the coast crept the Spaniards, Maldonado, Mendoza, Nuño de Guzman, Ferrelo, and the rest, including Cortes himself and Juan de Fuca, whose reputed voyage of 1592 is commemorated by the Strait that bears his name; and finally in the years 1774–1779 the memorable though belated voyages of Juan Perez, Heceta, and Bodega y Quadra in an effort to claim for Spain the entire Pacific coast. Meanwhile, however, in the year 1578 there had burst like a hurricane into the quiet waters of the Pacific the Englishman, Francis Drake, who so harried the ships and settlements of Spain that his name was spoken with horror for a century. Laden with Spanish booty, he too turned to the north and traveled as far as the 48th parallel in search of a safe passage home. Drake's Bay, a little north of San Francisco on the California coast, still marks the spot where he put in to refit after he had failed to find the Northwest Passage and was turning about for the Philippines, the Indian Ocean, the Cape, and home. Later on, the roster of explorers bears such names as the Russians, Bering and Chirikov in 1741; the Englishman, Captain Cook, greatest of navigators, 1778; and his worthy lieutenant and successor, Captain George Vancouver, 1792; La Pérouse, the Frenchman in 1786; the American, Gray, 1792, in his ship the *Columbia*, first to navigate the river that now bears her name; while overland to the Columbia basin there came through the trackless forest such men as Alexander Mackenzie, 1793, the discoverer of the great river of Northwestern Canada that bears his name; and Lewis and Clark (1804–1808) on their long journey for President Jefferson through the newly acquired Louisiana territory. Nor could one separate from the recital of discovery the tale of the fur traders; the fierce rivalries that flourished between the Hudson's Bay, the North-West, and the Russian-American Companies; their despotic rule over the far regions which they penetrated if they did not occupy; the story of such men as the Russian, Baranov, ruling from his camp at Kodiak for twenty years with an iron hand that brooked no opposition, exemplifying the Russian proverb that "God is high in the heavens and the Czar far away."

The Treaty of 1783 Establishing the Boundary

The limits of time, however, must be recognized, and we must confine our attention to-night to the more prosaic, but I trust not wholly uninteresting, theme of the geographical line itself and the historic and diplomatic reasons for its present location.

The preliminary treaty which closed the American War of Independence was drawn at Paris in the year 1782 by Richard Oswald on behalf of Great Britain, and Benjamin Franklin, John Adams, John Jay, and Henry Laurens for the United States. The definitive treaty was signed in the following year by David Hartley for Great Britain, and Adams, Franklin, and Jay for the United States. The northern and eastern boundary lines of the latter were described as follows:

> That all disputes which might arise in future on the subject of the boundaries of the said United States may be prevented, it is hereby agreed and declared that the following are and shall be their boundaries, viz.: From the northwest angle of Nova-Scotia, viz., that angle which is formed by a line drawn due north from the source of St. Croix River to the Highlands; along the Highlands which divide those rivers that empty themselves into the River St. Lawrence, from those which fall into the Atlantic Ocean, to the northwesternmost head of Connecticut River; thence down along the middle of that river to the 45th degree of north latitude; from thence, by a line due west on said latitude until it strikes the River Iroquois or Cataraquy; thence along the middle of said river into Lake Ontario, through the middle of said lake until it strikes the communication by water between that lake and Lake Erie; thence along the middle of said communication into Lake Erie, through the middle of said lake until it arrives at the water communication between that lake and Lake Huron; thence along the middle of said water communication into the Lake Huron; thence through the middle of said lake to the water communication between that lake and Lake Superior; thence through Lake Superior northward of the Isles Royal and Phelippeaux, to the Long Lake; thence through the middle of said Long Lake, and the water communication between it and the Lake of the Woods, to the said Lake of the Woods, thence through the said lake to the most northwestern point thereof, and from thence on a due west course to the River Mississippi; . . . East, by a line to be drawn along the middle of the River St. Croix, from its mouth in the Bay of Fundy to its source, and from its source directly north to the aforesaid Highlands which divide the rivers that fall into the Atlantic Ocean from those which fall into the River St. Lawrence.

The piously expressed purpose of the signers to prevent all future disputes reads, in the light of subsequent events, like the prohibition against litigation so beloved by gentlemen who draw their own wills, for hardly was the ink dry upon the treaty before disputes arose in reference to the boundary. In large part uncertainty was unavoidable. The map which the negotiators had before them was one made by John Mitchell in the year 1755 and, although not bad for its day and time, was sadly lacking in accurate detail. A veteran who had fought through the American Civil War on the side of the South was once asked what was the chief lesson he had carried away from that experience, to which he replied that it had made him "forever damned suspicious of these popular movements." If the history of the boundary teaches no other lesson, it should at least warn treaty makers

to be forever suspicious of paper boundaries based upon insufficient surveys.

Disputes in Reference to the River St. Croix

The first of these disputes concerned the identity of the River St. Croix, fixed by the treaty as the eastern boundary. There were three rivers which emptied into the Bay of Fundy at short distances from each other, viz., the Cobscook, Schoodic, and—fifty miles farther east—the Magaguadevic. The British authorities insisted that the middle river, the Schoodic, was the true St. Croix, while the Americans contended for the Magaguadevic. The difference became acute when Nova Scotia proceeded to grant land on the eastern bank of the Schoodic to loyalist refugees from the states, and Massachusetts, vigorously protesting, requested the Governor of Nova Scotia to recall "those subjects of His Majesty who have planted themselves within this commonwealth." To this the Governor of Nova Scotia firmly replied that Great Britain held to the Schoodic. With matters in this posture, America proposed the appointment of a Commission to settle the question, and in 1794, under the Jay-Wyndham Treaty, a joint commission of three was erected for the purpose. The Indian aborigines proved unsatisfactory witnesses, for they testified or were quoted impartially in favor of all three rivers; but excavations at the mouth of the Schoodic disclosed the remains of the Sieur De Monts' winter camp of 1604 and conclusively identified it as the St. Croix of Champlain.

It still remained, however, to determine the source of the St. Croix, as the point from which the due north line was to be drawn, and it appeared that not far from its source the Schoodic—henceforth to be known as the St. Croix—divided most perversely into two branches, an eastern and a western. Of these the former was the larger and therefore entitled to be considered the main stream; but to it the Indians had given the name of Chiputneticook, while the western kept the name of Schoodic. Without going into further detail, suffice to say that the commissioners decided for the eastern branch to its remotest spring, and it was and is so ordered.

If I were asked in what spirit this decision was accepted, perhaps I could do no better than recall the fact that during the war of 1812 the inhabitants on both banks of the St. Croix observed by common consent a strict neutrality. Some years later an official in charge of a powder magazine in the Canadian town of St. Stephen received from the Dominion or Provincial Governor a requisition for the powder under his control. He was constrained shamefacedly to reply that all the powder which the magazine contained had been loaned by him to the town of Calais, across the river, for a Fourth of July celebration and had not yet been returned. Commercially, matters have gone still further, for today these two cities are both supplied with water and electric light from works located on the Canadian side and run by a Canadian company, while their tramcars are operated by an American company with power generated in the United States.

Settlement of the Maine-New Brunswick Line

I must ignore the dispute over the ownership of the islands in Passamaquoddy Bay, which was finally settled by a joint commission under the Treaty of Ghent, Great Britain getting rather the best of it, and go on to the much more important question of the line "due north from the source of the St. Croix River to the Highlands . . . which divide those waters that empty themselves into the River St. Lawrence from those which fall into the Atlantic Ocean." Here we come to the threshold of actual war. The source of the St. Croix has been fixed; but where are the Highlands and where is the corresponding northwest angle of Nova Scotia?

Perhaps the worthies who signed the Treaty of Paris believed that a definite range of more or less mountainous highlands existed along the southern slopes of the St. Lawrence, although the word may be fairly taken to mean lands high enough to form a watershed; but the apple of discord was thoughtlessly flung by an American, James Sullivan, who writes in 1802 to James Madison, afterwards President but then Secretary of State, that "Commissioners have traversed the country in vain to find the Highlands designated as a boundary." This Madison repeated to Minister King, in London, with instructions to negotiate for a joint commission, thus admitting the existence of doubt upon the subject and conceding a point which it was impossible to regain. Henceforth the British contended for Mars Hill, an elevation but forty miles north of the St. Croix, as the true northwest angle of Nova Scotia, while the Americans insisted, in vain as the event proved, that the Highlands of the treaty were the watershed far to the north, between the tributaries of the St. Lawrence and the headwaters of the Restigouche. The controversy was destined to endure with increasing bitterness for over forty years. The crux of the matter, from the British point of view, was an all-British overland route from Halifax to Quebec, which the American claim, if successful, would intercept; while the Americans, and more especially the States of Maine and Massachusetts, stood stiffly on a strict construction of their treaty rights.

After some abortive negotiations a joint commission was finally set up under the Treaty of Ghent to determine and mark the boundary from the source of the St. Croix to the St. Lawrence. It held its first meeting at St. Andrews, New Brunswick, in September, 1816, and its last in New York, in April, 1822, but had nothing better to report, after discussions "characterized by not a little acrimony," than complete disagreement. There followed the usual bickering between the rival governmental authorities in the disputed area, and at last, in 1828, a convention was signed in London, submitting the question to the King of the Netherlands as arbitrator. On January 10, 1831, that monarch rendered his award. He decided that the term "Highlands" applied to land, not necessarily hilly, which divided waters falling in both directions; but he held the evidence insufficient to support a decision in favor of either contestant and recommended accordingly a line of conven-

ience which gave Great Britain 4,100 square miles of the 12,000 square miles in dispute, and assigned the remaining 7,900 to the United States.

President Andrew Jackson was inclined to accept the award and indeed regretted afterwards that he had not done so, but the States of Maine and Massachusetts insisted that it was decision and not compromise which they desired; the Senate of the United States took their point of view, with the result that this chance for a settlement was lost. After this matters went rapidly from bad to worse. While statesmen negotiated the people of the border took things more and more into their own hands. Persons seeking to hold elections in the Madawaska settlement under Maine laws were arrested by New Brunswick; a Canadian justice of the peace attempting to execute process was arrested by the New Hampshire militia; and an officer taking the census for Maine in the Madawaska settlement was arrested by the New Brunswick authorities. Word came that timber was being cut on a large scale, and Maine sent a posse to arrest any Canadians guilty of what she believed to be a trespass. The three leaders of the posse indiscreetly put up for the night at a house three miles distant from their followers, and this error of judgment led to their being seized and thrust into prison by the very Canadians whom they themselves were seeking; but as a counterblow the provincial "warden" McLaughlin was arrested by the posse and taken to prison at Bangor, Maine. Both sides soon released their captives on parole, but passions were high, and there followed the bloodless adventure known as the Aroostook War. Maine marched her militia into the disputed area, threw up fortifications, and appropriated $800,000 for military operations; and Congress, not to be outdone, appropriated $10,000,000 for war purposes and authorized the President to call out the militia of the several states and raise 50,000 volunteers. Fortunately, when matters were at this height, General Scott, of the United States Army, was sent to the scene and succeeded in arranging a *modus vivendi* which averted any clash of arms. It was agreed "that the civil posse of Maine should retain possession of the valley of the Aroostook, the British denying their right; the British authorities retaining possession of the valley of the upper St. John, Maine denying their right."

In 1841 Daniel Webster became Secretary of State; a year later Great Britain sent to Washington, at his suggestion, Lord Ashburton, the son of Sir Francis Baring, founder of the famous house of Baring Brothers and Company, with power to negotiate a settlement. The states of Maine and Massachusetts reluctantly despatched commissioners to participate. It was not all easy going. Webster writes to Edward Everett, then Minister in London: "Our movement for the last ten days, if any has been made, has been rather backward. The boundary business is by no means in a highly promising state, so many obstacles arise not only between us and England but between us and the Commissioners and the Commissioners of the two states themselves."

Perseverance had its reward, however, and an agreement was reached;

the line suggested by the King of the Netherlands was adopted in the main, with some alterations by which the area awarded to the United States was substantially reduced. Maine and Massachusetts were placated, although not appeased, by money grants from the federal treasury, and the long contest was ended. Webster and Ashburton each earned the usual praise that attends the peacemaker. The former was accused in the United States Senate of "victimizing that deserted and doomed state," Maine; and Lord Palmerston, in England, styled the treaty "Lord Ashburton's Capitulation" and recommended that he receive a new title as "Earl Surrender," declaring him, because of his American wife, "a most unfit person for the mission upon which he had been sent."

The Battle of the Maps

The episode cannot be dismissed without some reference to the famous Battle of the Maps. Jared Sparks, an American historian, while making some researches in Paris, found in the winter of 1841–1842 a letter from Benjamin Franklin to Comte de Vergennes, French Minister of Foreign Affairs, in which he said, "I have the honor of returning herewith the map your Excellency sent me yesterday. I have marked with a strong red line, according to your desire, the limits of the United States as settled by the preliminaries between the British and American plenipotentiaries."

Following the trail, Sparks found among the French archives a map of North America made by d'Anville in 1746, with a red line drawn completely around the United States in such fashion as to concede to Great Britain on the Maine boundary more than she had ever claimed. He communicated his discovery to Webster, and, while there was nothing to identify the map as the one which Franklin had marked or anything whatever to indicate the unknown tracer of the red line, Webster used the map with great effect in procuring the ratification of the treaty by the Senate and its acceptance by Maine and Massachusetts. Afterwards, when charged with having overreached Lord Ashburton in the matter, he said:

> I must confess that I did not think it a very urgent duty on my part to go to Lord Ashburton and tell him that I had found a bit of doubtful evidence in Paris out of which he might, perhaps, make something to the prejudice of our claims and from which he could set up higher claims for himself or throw further uncertainty over the whole matter.

It is gratifying, however, to reflect that Great Britain lost nothing by the incident, for Sir Robert Peel, in the debate of March 21, 1843, said that the British Government had, prior to Lord Ashburton's negotiation, itself found the famous map at Paris and added, "there can be no doubt but that it is the map referred to by Mr. Jared Sparks; but we can trace no indication of connection between it and the despatch of Dr. Franklin."

On the other hand, there was at the time of the negotiation and doubtless still is, in the British Museum, another red-line map of unquestioned authenticity which belonged to King George III. It is one of the Mitchell maps of 1755, such as the peace commissioners used. It bears a red line showing the

boundary as claimed by the United States, with the endorsement in the King's own handwriting, "Boundary as described by Mr. Oswald." Concerning it Lord Ashburton writes to Mr. Webster on April 28, 1843:

> The map question now, fortunately, only interests historians. . . . I should have some curiosity to know how you unravel this, to me, inextricable puzzle; at present I will only say, what I know you will believe, that the discoveries here are quite recent and were wholly unknown to me when I was at Washington. Not but that I agree entirely with you that it would have been no duty of mine to damage the cause of my client, yet at the same time I perhaps went further in my protestations of ignorance than I otherwise should have done.

Let us leave it to be discussed by the shades of Webster and Lord Ashburton in the Elysian Fields, since neither party to the contest looks for a rehearing of the case.

The Boundary through the Lakes and Westward to the Rockies

Of the boundary through the lakes and from Lake Superior to the Rocky Mountains I shall say but little, for there is bigger game ahead of us on the far side of the Continental Divide. You will remember, however, that the treaty of 1783 called for a line from the most northwestern point of the Lake of the Woods due west to the River Mississippi. Here again a surveyor was asked to accomplish the impossible, for the Mississippi, instead of running to the west of the Lake of the Woods, has its rise some 100 miles to the south. The line proposed vanished into the air. By a treaty negotiated in London in 1818, Robinson and Goulburn acting for Great Britain, and Gallatin and Rush for the United States, it was agreed to run a line from the most northwestern point of the Lake of the Woods due north or south, as the case might be, to the 49th parallel and then to follow that parallel to the Stony—now called the Rocky—Mountains. It was found that a line run due south twenty-six miles accomplished the purpose.

The selection of the 49th parallel involved no difficulty, for it was already recognized as a boundary line. At the peace of Utrecht, which closed the War of the Spanish Succession, Great Britain and France had undertaken a century before to fix their respective claims upon the American continent. France contended that her territory extended to the north to within fifty miles of Hudson Bay, while Great Britain insisted that the Hudson's Bay Company possessed the land to the 49th parallel. No express agreement was reached, but thereafter upon all English maps the 49th parallel was carried as the boundary line. In 1803 President Jefferson purchased from Napoleon, for $15,000,000, the Louisiana territory, perhaps the largest and most profitable real estate transaction on record; and, the United States having taken the place of France, the 49th parallel was accepted as the uncontroverted boundary line.

From the Rocky Mountains to the Pacific

There was, however, a question which the negotiators of 1818 were unable to solve, as were also those who, four years earlier, had framed the Treaty

of Ghent; this was the boundary from the Rocky Mountains to the sea, which involved the whole thorny question of sovereignty over the Oregon country. Gallatin and Rush proposed that the 49th parallel should be accepted to the ocean, but the British negotiators intimated that they would be content with nothing short of the line of the Columbia River. It was an unbroken wilderness they were discussing, and aside from the voyages of discovery the only white men who had penetrated it were the fur traders, drawn there principally by the lure of the skin of the sea otter, who thus made his contribution to the march of civilization. It is easy to think that others are grasping when they desire what we covet ourselves. Perhaps you will care to listen to the remarks of Minister Rush upon the ambitions of his British confrères:

> Under this branch of the discussion might be seen power seeking its own augmentation. How strong the case for this reflection. A nation whose dominions in Europe established her in the front rank of power; whose fleets predominated on the ocean; who had subjects in Asia too numerous to be counted; whose flag was planted at the Cape of Good Hope and other posts in Africa; who had Gibraltar, and Malta, and Heligoland, enabling her to watch the Mediterranean and the Baltic; who had an Empire in the West Indies as in the East, and added to all, vast continental colonies in America—this nation was anxiously contending for territorial rights in deep forests beyond the Rocky Mountains and on the solitary shores of the northern Pacific.

And so, for want of agreement, it was written down that any country claimed by either party on the northwest coast of America westward of the Stony Mountains should be free and open for the term of ten years to the citizens of both powers without prejudice to their respective claims of sovereignty.

Russian Part in the Contest

It was really a three-cornered contest, for Russia, having seated herself firmly in Alaska, was pressing down from the north, and the United States upward from the south, with Great Britain in between, struggling to maintain her footing on the coast. Spain ceded to the United States in 1819, by the Treaty of Florida-Blanca, whatever rights north of the 42nd parallel had inured to her by her voyages and discoveries and definitely retired from the field. In a sense it was Russia that forced the issue by the famous ukase of the Emperor, issued in 1821, which forbade "all foreign vessels not only to land on the coasts and islands" between Bering Strait and the 51st parallel "but also to approach them within less than 100 Italian miles" under penalty of confiscation of vessel and cargo. This was high language and naturally unacceptable either to Great Britain or America, who, as they have shown in very recent history, do not tamely accept a warning to keep off the open sea. Both promptly protested, Great Britain caring—as Canning frankly confessed—more about the principle involved than about the territory. "We negotiate about territory," he wrote, "to cover the remonstrance upon principle." Indeed, it may be questioned whether throughout the long controversy Great Britain was fully alive to the possibilities of the region. There

is a fable still extant to the effect that as late as 1846 Captain Gordon, a representative of Great Britain, became so disgusted because the Columbia River salmon would not rise to a fly that he reported to his Government that the "country was not worth a damn." However this may have been, the Russian ukase could not be borne. Negotiations were entered into accordingly, and in 1824 it was agreed between the United States and Russia that the citizens of the United States would not form settlements north of latitude 54° 40′ and that Russian citizens would form no settlements south of it. The next year Great Britain concluded a treaty which again limited Russia on the south by latitude 54° 40′ and on the east by the first range of mountains on the 141st meridian. This eliminated Russia and left Great Britain and the United States to fight it out.

The Opposing Claims

Each of them continued to claim the entire territory, relying upon a sequence of events which may be briefly stated. The British claim was based on

1. The exploration by Captain Cook, in 1778, of the Pacific coast from latitude 43° N. to 70° N.
2. The establishment by British merchants, in 1788, of a trading post at Nootka Sound, which, although seized by Spain in 1789 together with two British ships that were anchored there, was restored by the treaty of 1790, which also recognized Great Britain's fishing and treaty rights in the Pacific.
3. The explorations of Vancouver in 1792–1794 of a part of the coast and waters of Juan de Fuca Strait and the Gulf of Georgia and the exploration by Alexander Mackenzie and fur-trading settlements by the North-West Company during the same period in the country north of the Columbia River.

The claim of the United States was based on

1. The discovery in 1792 of the Columbia River by Robert Gray, who entered and explored the river for twenty-three miles, giving it the name of his ship.
2. The expedition of Lewis and Clark, in 1803–1806, who came by the way of the Mississippi and Missouri Rivers across the Continental Divide to the headwaters of the Columbia, thence down the Clearwater, Snake, and Columbia Rivers to the Pacific Ocean.
3. The establishment in 1811 by the Pacific Fur Company, organized by John Jacob Astor of New York, of the fur-trading settlement near the mouth of the Columbia River, which was named Astoria. This had been taken by the British during the war of 1812 but was restored to the United States on the conclusion of peace.

In addition to these specific events the United States sought to strengthen its title by claim of succession to all rights held in the territory by either Spain, France, or Russia; in the case of the latter by renunciation, and under Spain and France by grant.

The Oregon Treaty

Whatever merit there may have been in these conflicting claims proved in the end of minor importance, for it was effective occupation rather than historical rights that finally decided the question. Time was on the side of the Americans. Minister Rush knew this, in 1818, when he wrote that "in regard to those interests in the remote West, time is for the United States the best negotiator"; and Calhoun had the same thought in mind when he recommended, in 1843, a policy of "wise and masterly inactivity." No settlement having been reached, the arrangement for joint occupation was extended in 1827 for an indefinite period, subject to abrogation by either party on twelve months' notice; and a tide of American immigration set in which continued with increasing volume. As usual, missionaries were in the van, stimulated by the coming of four Indian chiefs to St. Louis seeking enlightenment. One thousand immigrants arrived in 1843; fourteen hundred more in the following year; and by 1846 there were in the disputed area 7,000 American settlers as against 400 British. A Provisional Government was erected by the settlers, to which the representatives of the Hudson's Bay Company somewhat surprisingly became parties. Meanwhile the Presidential election of 1844 came on, and President Polk was elected upon the famous campaign slogan of "Fifty-four-forty or fight;" in other words, a demand for the whole territory to the Russian line. Once installed, however, he announced that, while he stood for "Fifty-four degrees and forty minutes," he would refer any suitable proposition to the Senate; and Great Britain, acting upon the hint, offered the 49th parallel, reserving the whole of Vancouver Island and the free navigation of the Columbia. The offer was promptly accepted and concluded by the so-called Buchanan-Pakenham or Oregon Treaty signed at Washington on June 15, 1846, fixing the boundary as the 49th parallel from the Rockies to "the middle of the channel which separates the continent from Vancouver's Island, and thence southerly through the middle of said channel and of Fuca's Straits to the Pacific Ocean."

San Juan Island

You would be glad, I am sure, to have the recital of this long-drawn-out controversy end here, but there still remains to be told the tale of the pig that was killed on San Juan Island. No sooner was the treaty signed than men began to ask which was the "channel that separates the continent from Vancouver's Island." Rosario Strait, said Great Britain, which, though it does not wash the continent, lies nearest to it; Haro Strait, said America, which is nearest to Vancouver; and between the two lay San Juan and a

group of smaller islands waiting to find out under which flag they belonged. The diplomats debated until the fateful year 1859, when an American citizen shot and killed, on San Juan Island, a pig belonging to the Hudson's Bay Company. He was threatened with arrest and removal to Victoria for trial, but his lusty cry for help reached a hot-blooded American general on the mainland, who promptly despatched troops to seize and occupy the island. Great Britain protested immediately, and the same General Scott who had watered down the Aroostook War was sent again to the scene of action and arranged a joint occupation of the islands by 100 men of each nation. An adjustment might have been hastened after this, but America —at least from 1860 to 1864—had other things to think about; and it was only in 1871 that a treaty was finally ratified submitting the question to the German Emperor for decision. His award, rendered in 1872, upheld the American contention that Haro Strait was "most in accordance with the true interpretation of the treaty" of 1846. Thus the threatened slayer of the pig was at last secure. But when the roll of animals that have made their place in history is called—the geese that saved Rome, the spider that re-inspired the Bruce, the cow that kicked over the lamp and started the great Chicago fire—is it too much to ask that the pig of San Juan Island may not be forgotten?

The Alaskan Boundary

There remains but one more controversy to be considered. We must not stop until we have finally located the Alaskan boundary. In 1867 the United States purchased from Russia the territory of Alaska for $7,200,000, or at the rate of about two cents an acre. Some of the Congressional wise-acres of the day denounced it as an act of "ineffable folly" and "wanton profligacy," but it has not turned out so badly after all. America, of course took only what Russia held, and the latter had agreed with Great Britain in 1825 that the boundary between them should run from the southernmost point of Prince of Wales Island to latitude 54° 40′, ascending the Portland Channel to the 56th degree of north latitude, thence "follow the summit of the mountains situated parallel to the coast" to the 141st meridian, and with it to the Arctic Ocean; provided, however, that whenever the summit of the mountains referred to should "prove to be at the distance of more than ten marine leagues from the ocean" the limit between the two countries should be "a line parallel to the windings of the coast and which shall never exceed the distance of ten marine leagues therefrom." There was given to British subjects in perpetuity, by the sixth article of the treaty, the right to navigate all rivers and streams draining into the Pacific that crossed this coast strip, or *lisière*.

To the date of the American purchase this boundary line had never been traced upon the ground, and surveys made thereafter disclosed the disturbing fact that no continuous range of mountains parallel to the coast existed; on the contrary, the coast country was broken into an irregular "sea of mountains" over which it would be entirely impossible to trace a winding line ten

leagues from the coast. The result was, as the American Minister in London, Mr. Phelps, wrote to the Marquis of Salisbury in 1886, that "these treaties really give no boundary at all so far as this portion of the territory is concerned."

Languid efforts were made from time to time at settlement, but in 1896 an event occurred that made the question one of immediate importance. This was nothing other than the discovery of gold in the Klondike region, which provoked a tremendous inrush of eager gold seekers into the valley of the Yukon. The shortest route lay over the White and Chilkoot Passes; on their ocean side the towns of Dyea and Skagway sprang into existence along the Lynn Channel almost over night; and it became a matter of consequence, from the standpoint of customs duties and administration, to decide where the sovereignty of the region lay. A provisional boundary was agreed upon as a *modus vivendi*, and the two countries addressed themselves in earnest to the determination of their respective rights. To this end a convention was concluded in 1903, referring the question to a tribunal to be composed of "six impartial jurists of repute," three to be selected by the United States and three by Great Britain, who proved to be, on the part of Great Britain, Lord Alverstone, Sir Louis Jette, and Sir Allan Aylesworth and for the United States, Senators Root, Lodge, and Turner.

Reduced to its simplest terms the issue turned upon the meaning of the terms "coast" and "ocean," from which, under the treaty of 1825, the ten marine leagues were to be measured. The Alaskan coast hereabouts is inconceivably broken and rugged, penetrated by many deep and narrow bays, inlets, or channels into the heads of which pour numerous rivers, large and small. It resembles on the map a gigantic saw, with teeth projecting seaward far from the blade. In brief, Great Britain contended that the ten-league line should be measured from the outermost points of the coast, the tip of the teeth, with the result that the line would hardly strike the blade at all and the heads of nearly all the conspicuous bays and inlets would lie in British territory. America argued that the measurement must begin at tidewater wherever found, that is to say at the head of the deepest inlet, or where the saw tooth joined the blade. She sought to draw an unbroken land line ten leagues from any salt water.

The Commission sat on September 3, 1903, and rendered its decision on October 20. I shall not detail the reasoning by which able counsel defended the respective claims, except to say that the American representatives pointed out that if the British construction were correct, the clause of the treaty giving to British subjects the right to navigate the rivers and streams crossing the *lisière* was entirely unnecessary and meaningless, as all these rivers would empty on British territory into British waters. The tribunal, by a vote of four to two, Lord Alverstone voting with the Americans and the two Canadian members dissenting, decided substantially in favor of the American claim and drew a line joining certain designated peaks, which has been run and surveyed accordingly.

Marking the Boundary

This completes the story, and from the Arctic to Cape Muzon, from the Pacific to the Atlantic, we have settled all the controversies of moment and have fixed the definite location of the boundary line. You will agree that a result, attained at the cost of so much effort, which means so much to the millions of people now living along the border and to the many millions more who will crowd it in the future, must not be exposed to the hazard of mistake or forgetfulness. I am glad to report that the duty to prevent this has not been neglected. This brings me to say a few words of the labor that has been and is being expended to mark the boundary for the benefit of this and of coming generations.

Under a series of treaties between Great Britain and the United States, dated in 1903, 1906, 1908, and 1910 respectively, the marking of the boundary from end to end has been assigned to two commissions; the land boundary to be marked by the International Boundary Commission—which is composed of two members, one Canadian and one American; the water boundary by the International Joint Commission on Waterways—composed of six members similarly divided. Some fugitive work had been done before. After the Webster-Ashburton Treaty of 1842, two gentlemen, Colonel J. E. Bucknall-Estcourt on behalf of Great Britain and Mr. Albert Smith for the United States, were designated to mark the line from the St. Croix River to the St. Lawrence. They went diligently about it, and erected some 700 triangular iron boundary posts, bearing on one face the legend, "Boundary, Aug. 19th, 1842;" on the second, "Lt.-Col. J. B. B. Estcourt, H. B. M. Comr.;" and on the third, "Albert Smith, U. S. Comr.;" but the posts are discreetly silent as to the names of the countries in interest. Perhaps one might characterize this as an example of monumental egotism. On the far western reaches of the boundary some posts had been erected, and also some mounds of earth and stone cairns, but the marking was inadequate where it existed at all; but now, as a result of the labor of these commissions, the line is thoroughly marked and monumented from end to end, except where the far northern snow fields make permanent marks impossible. On the land boundary five-foot posts of aluminium bronze, set in concrete, are stationed at intervals of from one to four miles, inter-visible, so far as practicable, and twenty-foot sky-line vistas have been cut through the forest; by water, range marks and finders are set along the visible shore at every turning point, and the line is charted through the broader waters. A series of accurate topographical maps, now almost finished, will complete a record made and signed under joint supervision that will always endure. The work has demanded infinite care, a vast amount of mathematical computation, and much labor both of body and of brain. Sad to say, it has not been accomplished without some loss of life in the rugged mountains and snows of the far Northwest. Of all this interesting stories might be told, did time permit. It is worth its cost, for however Great Britain and America may disagree

in the years that are to come, quarrels over their common boundary are at an end forever.

I return to the thought with which I began. In the thirties of the last century the United States was greatly concerned when it appeared that a resurvey of the boundary on the 45th parallel would prove that the one million dollars they had spent in fortifying Rouses Point, New York, at the end of Lake Champlain, had been expended upon British soil. The land was conceded to America, but there is no fortification there today. When the German Emperor awarded San Juan Island to the United States, in 1872, wild predictions were made of the forts the United States would build upon it to threaten the city of Victoria. A half century has come and gone, and even the marks of our joint military occupation have disappeared. Any member of the Canadian Parliament or American Congress who offered now a bill appropriating money to fortify the border would be regarded as mildly insane. In 1817, by a simple exchange of diplomatic notes, war vessels were banished from Lake Champlain and the Great Lakes, and the agreement, adjusted to meet the changing conditions of ship construction and revenue patrol, endures to this day. So it has been, so may it continue. Need I point the obvious moral? Is it not the old truth that trust is wiser than distrust, that confidence is nobler than jealousy, and that there are saner ways than war for nations to settle their disputes? Long may these neighbor commonwealths endure to teach that lesson to the world; and, if ever in the future passions should agitate or angry words divide them, may they turn for admonition and for warning to the Unguarded Boundary.

ON THE LATE-GLACIAL AND POST-GLACIAL HISTORY OF THE BALTIC

By Ernst Antevs

Probably no other inland sea has as great and many-sided a scientific interest as the Baltic. There, owing to an unusually happy combination of circumstances, those *varve*, annual laminae of, clays and silts were deposited which enabled Gerard De Geer and Ragnar Lidén to obtain the exact geochronology of the last 13,500 years. Extensive alterations of level since the disappearance of the last land ice have changed considerably the outline of the Baltic. At first exclusively supplied with fresh water by the vanishing ice sheet, at times connected with the ocean by sounds, and at other times separated from it, it also underwent great changes in salinity. Along with these variations there were marked changes in climate, fauna, and flora. Since time immemorial the shores of the Baltic have been the home of the Nordic race; and so the long history of this sea is geological, geographical, and archeological.

In this article only those features of the physical history of the Baltic will be treated the interpretation of which has recently undergone fundamental modifications and which are essential to the solution of other problems. Thus, I shall deal mainly with the changes of level[1] and shall only touch upon the climatic evolution and the immigration and changes of fauna and flora.

Amount of the Oscillations of Level in the Southern Baltic

The isobase of zero or line which marks the outer limit of late-glacial and post-glacial[2] upwarping of northern Europe—assuming sea level to have been constant—crosses Zealand in a northwest-southeast direction, touches Rügen and Pomerania, and continues in a curve towards the east-northeast.

Inside, or north, of this zero isobase at the disappearance of the ice the land was submerged. It has since undergone repeated elevations and subsidences. The net result is uplift.

Outside, or south, of the isobase of zero, on the contrary, the land lay higher than it does now. According to the German geologists North Germany then stood at the highest elevation it ever reached in all late-glacial

[1] C. E. P. Brooks (The Evolution of Climate in North West Europe, *Quart. Journ. Royal Meteorol. Soc.*, No. 199, Vol. 47, 1921, pp. 173–194, London; reviewed by Ellsworth Huntington in *Geographical Review*, Vol. 12, 1922, pp. 126–130) largely bases his opinion of the causes of the climate of northern Europe in late Quaternary time on the old view of the changes of level.

[2] *Post-glacial* time, according to this chronology, begins the year after the bisection of the shrinking ice sheet at Ragunda in northern Sweden. The term *late-glacial* refers to the time occupied by the recession of the last ice sheet up to the event mentioned. See also the table on page 605 and the map on page 604.

and post-glacial time.[3] More probably the maximum elevation was attained somewhat after release from the ice, as seems to have been the case in southern New England.[4] Since the highest level was reached the region has probably undergone an almost uninterrupted slow subsidence down to its present level. As far as is known, there was no uplift during Ancylus time, i.e. the fresh-water stage of the Baltic in early post-glacial time.[5]

How much higher North Germany stood in late-glacial and early post-glacial time has not been determined, as the only possible records of this have sunk below the level of the sea. A minimum figure of the elevation at a somewhat later stage, however, has recently been determined. When the ice edge receded over southern Sweden the southern Baltic formed an ice-ponded lake, which was drained to sea level when the ice edge left Mt. Billingen, northeast of Gothenburg, and a lower region was uncovered. This lowering of the Baltic amounted to 17 meters.[6] Consequently, the thresholds in the southwestern Baltic, at that time, stood at least 17 meters above the sea. Since the Darsser Schwelle, between Falster and the German mainland, now reaches a depth of 18 meters, the southwestern Baltic region then stood at least 35 meters higher than now. When the ice was receding from southern Sweden, the tract probably stood somewhat higher than this, although no reliable evidence has been presented of a higher stand than 35 meters. Statements as to very high elevation, particularly in early post-glacial (Ancylus) time, have been found to lack real basis. Thus, in the southwestern Baltic terrestrial and semiterrestrial formations—peat, for example—have only been met with down to a depth of about 20 meters, viz. on the Oderbank and at Travemünde.[7] The greatest depths at which such formations have been found north of the isobase of zero are 14 meters at Copenhagen[8] and 9 meters south of Bornholm.[9] The alleged evidence from the southeastern Baltic that the topographical conditions in the Leba-Rheda valley,[10] north-

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[3] C. Gagel: Die sogenannte Ancylushebung und die Litorinasenkung an der deutschen Ostseeküste, *Jahrbuch Königl. Preuss. Geol. Landesanstalt zu Berlin*, Vol. 31, 1910, pp. 203–226.

Theodor Otto: Der Darss und Zingst. Ein Beitrag zur Entwicklungsgeschichte der vorpommerschen Küste, *Jahresberich Geogr. Gesell. zu Greifswald*, Vol. 13, 1911–12, pp. 235–485; reference on pp. 312–316.

[4] Ernst Antevs: Recession of the Last Ice Sheet in New England, *Amer. Geogr. Soc. Research Ser. No. 11*, 1922.

[5] Gagel, *op. cit.*, p. 204.

Otto, *op. cit.*, pp. 310 and 321.

E. Geinitz: Diluvialstudien im östlichen Mecklenburg, *Archiv Vereins der Freunde der Naturgeschichte in Mecklenburg*, Vol. 66, 1912, p. 187. Rostock.

[6] G. Lundqvist: Den baltiska isjöns tappning och strandlinjerna vid Billingens nordspets, *Geol. Fören. Förhandl.*, Vol. 43, 1921, pp. 381–385. Stockholm.

[7] Gagel, *op. cit.*, p. 222.

Otto, *op. cit.*, p. 315.

[8] Ernst Antevs: Some Corrigenda, *Geol. Fören. Förhandl.*, Vol. 40, 1918, p. 892–893. Stockholm.

[9] K. A. Grönwall and V. Mitlhers: Kortbladet Bornholm, *Danmarks Geol. Unders.*, Ser. 1, No. 13, 1916; reference on pp. 236 and 244. Copenhagen.

[10] Alfred Jentzsch: Ueber einige Züge in der Oberflächengestaltung Westpreussens, *Zeitschr. Deutsch. Geol. Gesell.*, Vol. 42, 1890, pp. 613–618; reference on p. 617.

Idem: Das Präzisions-Nivellement Lauenburg-Neustadt-Rheda. Eine Studie zur Frage nach senkrechten Boden-Bewegungen, *Jahrbuch Königl. Preuss. Geol. Landesanstalt zu Berlin*, Vol. 33, 1912, Part II, pp. 367–384.

K. Keilhack: Die Stillstandslagen des letzten Inlandeises und die hydrographische Entwickelung des pommerschen Küstengebietes, *ibid.*, Vol. 19, 1898, pp. 90–152; reference on p. 145.

Idem: Geol. Zentralbl., Vol. 22, 1915, No. 31.

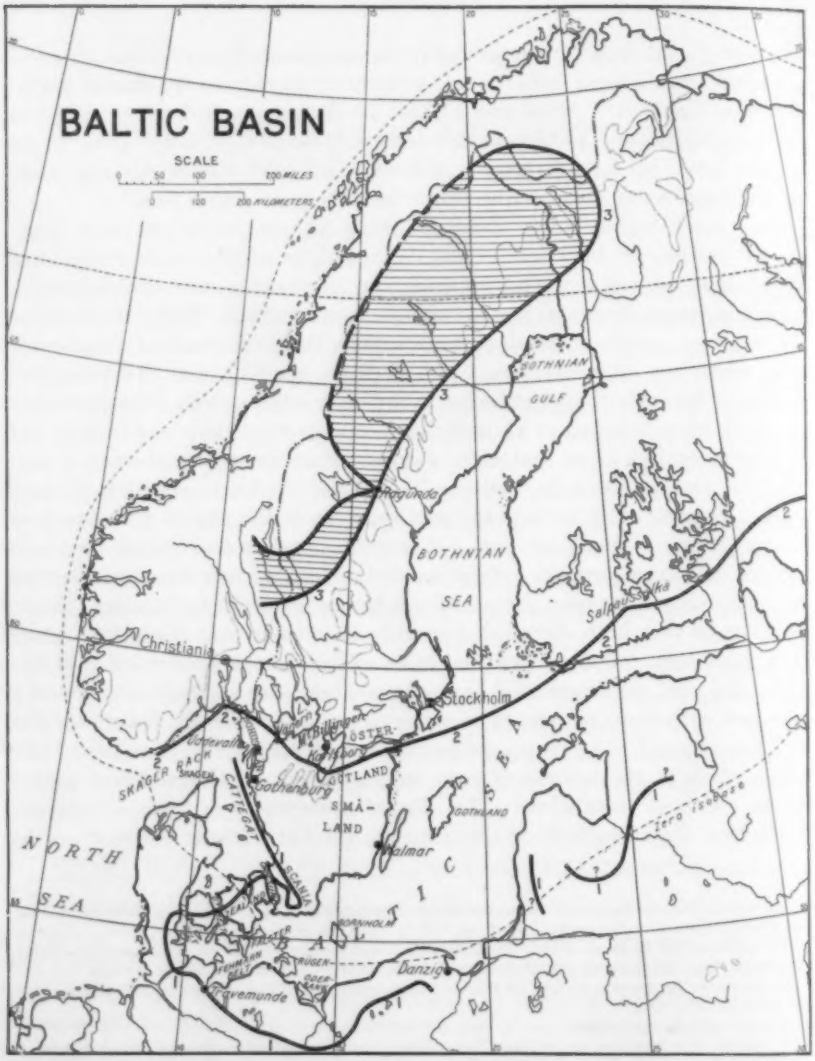

FIG. 1—Map illustrating the late-glacial and post-glacial history of the Baltic Basin. The numbered lines indicate the position of the ice edge at the beginning of (1) goti-glacial (after Gerard De Geer: Om naturhistoriska kartor över den baltiska dalen, *Pop. Naturvet. Revy*, 1914, pp. 189–200 and Pls. 1–4, Stockholm), (2) fini-glacial, and (3) post-glacial time respectively. Ice remnants in Sweden, at the beginning of the post-glacial epoch, are shown by shading. The light broken line is the zero isobase. (The base upon which these data are shown is Northwest Europe, No. 215, in Goode's Series of Base Maps, The University of Chicago Press, 1920; the scale is approximately 1:13,500,000.)

Chronology (Gerard De Geer and Ragnar Lidén)			Changes of Level in Bohuslän (Ernst Antevs)	Stages in the Baltic (Modified from Henrik Munthe and others)
0	A.D. 1900			
1,000	Recent			
2,000			Present level reached	Limnaea: salinity decreases
3,000			Elevation	
4,000	Post-glacial			
5,000			Submergence (Tapes)	Littorina: salinity twice that at present; submergence
6,000			Elevation	
7,000			Submergence	
8,000		Bisection of ice remnant at Ragunda	Elevation	Ancylus: fresh-water inland sea; submergence
9,000	Fini-glacial	Ice retreat from the Fenno-Scandian moraines (inclusive) to Ragunda	Submergence	Sea connection through central Swedish straits
10,000			Elevation	Drainage of last Baltic ice lake at Billingen
11,000		Ice retreat from south Scania, the Danish Islands, and North Germany to the Fenno-Scandian moraines	Submergence Elevation	South Baltic ice lakes and fresh water inland seas
12,000			Depressed to marine limit, as released from the ice, but rising	
13,000	Goti-glacial	Central Scania released from the ice about 13,500 years ago		
13,500		Time represented in the outermost part of the zone unknown		

Fig. 2—Chronology for eastern and western Sweden. Intended to show the relationship between the principal events in eastern and western Sweden and to combine them with the De Geer-Lidén exact chronology.

The term goti-glacial is derived from Gothia, the modern Götaland or southern Sweden; fini-glacial has reference to the final stage of the ice recession.

The present surface salinity in the Baltic is: South of Scania 0.8 per cent, at Gothland 0.7 per cent, in the southern Bothnian Sea 0.5 per cent, and in the northern Bothnian Gulf 0.2 per cent. In the southern Öresund the surface salinity is 1.1 to 1.2 per cent, at Skagen 3 per cent and in the Atlantic 3.5 per cent.

west of Danzig, indicate an elevation in late-glacial time of at least 50 meters above the present seems to be illusory.[11] This is doubtless the case also with the evidence presented by Munthe [12] that the "river-channel-shaped depressions" in the Danish Belts and in the Öresund indicate the base of river erosion in Ancylus time; for Spethmann's[13] bathymetrical map shows clearly that these depressions cannot have been eroded by rivers, as they consist of series of narrow basins separated by thresholds which at some points are very shallow and broad. These depressions, as Gerard De Geer has orally pointed out, probably mark lines of fracture.

Ancylus Lake—A Fresh-Water Inland Sea

In the beginning of the post-glacial epoch the Baltic was characterized by fresh water, as has been known for 35 years especially through Munthe's valuable studies of its subfossil fauna and flora. At the same time a well recorded and extensive transgression took place in the central and southern Baltic region. The fresh water proved in Munthe's opinion that the Baltic was a true lake separated from the sea. The Baltic of that time has therefore been called the Ancylus lake. The transgression has been explained by a more rapid rising of northern Scandinavia than of the southern part, by which the water masses were shifted southward causing the water level to rise there. This explanation assumes a very high elevation of the southern Baltic region.[14]

As the present writer [15] pointed out, however, the fresh water of the Ancylus lake can be explained without the assumption of its being excluded from the sea by referring it to an excessive supply of ice water from the ice sheet. This makes it unnecessary to accept the changes of level as set forth by Munthe, which are hardly acceptable in themselves and which disagree with evidence more recently obtained in western Sweden. A consideration of the conditions which govern the present salinity of the Baltic [16] will make clear the basis for this new view of it as a fresh-water inland sea during Ancylus time.

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[11] Gagel, *op. cit.*, p. 219.

E. Wunderlich: Postglaziale Hebung in Westpreussen und Hinterpommern, *Zentralbl. für Mineral., etc.*, 1914, pp. 464–468.

[12] H. Munthe: Studies in the Late-Quaternary History of Southern Sweden, *Geol. Fören. Förhandl.*, Vol. 32, 1910, pp. 1197–1293; reference on p. 1205. Stockholm.

[13] Hans Spethmann: Tiefenkarte der Beltsee, *Petermanns Mitt.*, Vol. 57, II, 1911, pp. 246–251 and Pl. 29.

[14] Munthe, *op. cit.*, p. 1205, Pl. 46B.

Idem: Studier öfver Gottlands senkvartära historia, *Sveriges Geol. Unders.*, Ser. Ca, No. 4, 1910; reference on pp. 36–38, 178, 205. Stockholm.

[15] Ernst Antevs: Post-glacial Marine Shell Beds in Bohuslän, *Geol. Fören. Förhandl.*, Vol. 39, 1917, pp. 247–425; reference on p. 257. Stockholm.

[16] Otto Pettersson: Resultaten af den internationella hafsforskningens arbete, *Kungl. Jordbruksdpt. Meddel. 14*, 1907; reference on p. 89. Stockholm.

Idem: Strömstudier vid Östersjöns portar, *Svenska Hydrograf.-biolog. Komm. Skrift.*, No. 3, 1908. Gothenburg.

Idem: Über Meeresströmungen, *Veröffentl. Inst. für Meereskunde*, No. 13, 1908. Berlin.

Otto Krümmel: Die deutschen Meere im Rahmen der internationalen Meeresforschung, *Veröffentl. Inst. für Meereskunde*, No. 6, 1904.

Idem: Handbuch der Oceanographie, 2 vols., Stuttgart, 1907, 1911; reference in Vol. 1, p. 350.

Present-day Salinity of the Baltic

At the present time the Baltic is connected with the ocean by the Öresund and the Fehmarn Belt.

The south Öresund, 8 meters deep, generally allows only an outward-flowing current to pass through. During long and continued northwesterly winds, however, a turn of the current sometimes sets in which carries some sea water across the threshold.

The Fehmarn Belt, on the sill between Falster and Darsserort, is at most 18 meters deep. Here a surface current usually flows outward to the Cattegat, while a bottom current flows inward to the Baltic. The outgoing surface current is formed by a mighty wedge-shaped layer of Baltic water of a homogeneous salinity of 0.7–0.8 per cent. The incoming undercurrent is brought about by a thin wedge of heavier water of 0.9–1.2 per cent salinity, as often as this is forced across the threshold by the excess of atmospheric pressure on the North Sea over that on the Baltic. When the conditions of atmospheric pressure are reversed the undercurrent does not get through, and the outgoing Baltic waters occupy the whole cross section of the channel.

To what degree and how rapidly the salt water which thus comes in across the thresholds is mixed with the brackish water of the Baltic is not yet fully made out; for, in spite of the fact that a lively circulation takes place in the inland sea, the presence of salty bottom layers, particularly, proves that the mixing is very incomplete. As it seems probable that the mixing of two water masses is rendered more difficult by great contrasts in their gravity or salinity, the mixing was probably still less effective in late-glacial and early post-glacial times than now.

In this connection the present conditions in lake Mälaren, at Stockholm, are significant because they are so well known, and because this lake is related to the Baltic much as the Baltic during long periods in late-glacial time was related to the Western Sea. It must be kept in mind, however, that the circulation and the mixing of the waters in Mälaren, no doubt, are less than was and is the case in the large Baltic.

The channel between Mälaren and the Baltic, the Norrström, in Stockholm, is exceedingly short and narrow, and the threshold lies about 4 meters below sea level.[17] Mälaren has fresh water and the Baltic brackish. If, as sometimes happens, the water level of the Baltic rises above that of the lake, brackish water enters. This water, however, does not mix with the fresh water but essentially forms well-defined beds in the upper water layers which are sooner or later carried off by the outward-flowing current. To some extent the brackish water comes to rest on the bottom in the deepest parts of the basin. Such brackish bottom layers occur as far as 20 kilometers (12.5 miles) up the lake and are removed only when storms agitate the water so strongly that the brackish beds rise to the surface. Under

[17] Klas Sondén: Vattnet i sjöar och vattendrag inom Stockholm och dess omgifningar, *Bihang 2 till Stockholms stads hälsovårdsnämnds årsberättelse 1910*, Avd. 1, 1912. Stockholm.

normal conditions during 1909–1911 the proportion of salt in the deep holes in the part of Mälaren called Ekeröfjärden, 10 kilometers west of Stockholm, was 0.2 per cent; while in the Trälhavet, a bay of the Baltic 20 kilometers northeast of Stockholm, at a depth of about 10 meters, the proportion was 0.5 per cent.

We may now apply these principles to the conditions which obtained in late-glacial time.

Application to Conditions in Late-Glacial Time

When the land ice left the southern part of the Baltic basin, it was of course replaced by fresh ice water. As the recession went on, the growing lake received enormous supplies of fresh water from its large drainage area. By the tilting of the land the waters were shifted southward, creating strong outward-flowing currents through the Öresund, the sounds in central Sweden, and perhaps in other places, diluting the water in the Western Sea and holding back the incoming currents.

When the receding ice border uncovered the Fehmarn Belt, that channel stood at a high level. After the highest elevation had been reached it was submerged, until it finally became so deep that a salt undercurrent could force its way through the strait into the Baltic basin. Judging from the present conditions at the entrances to the Baltic, its depth was then more than 10 meters, perhaps 15 meters. Consequently this may have happened in late Ancylus time, for the region had reached its present level at the maximum of the Littorina subsidence, as shown by shore lines, shell beds, peat bogs, etc.

The changes in the level of the southern Öresund are little known, but it seems likely that the region in late-glacial and early post-glacial times for long periods lay higher than now. At the beginning of the fini-glacial epoch, indeed, it stood considerably higher.

During late-glacial and early post-glacial times, consequently, it is probable that no sea water passed in through the Fehmarn Belt and only an inconsiderable quantity through the Öresund. Incomparably more brackish water must have forced its way in through the sounds which, in fini-glacial time, existed in central Sweden. These sounds were wider and several times as deep and, furthermore, were situated directly opposite the Skagerrack and North Sea. They, however, were relatively short-lived and had, as indicated by the subfossil fauna and flora as well as by the sediments, only inconsiderable and local influence on the salinity of the Baltic.

After coming in through the straits, part of the brackish water probably settled down in the nearest deep basins and remained there for a long time more or less unmixed with the fresh water. Another part spread along the bottom over the central Swedish lowland and, probably, the southwestern district of Finland. Still another part was immediately carried off again by the strong outflowing current.

With the brackish water came a scanty marine fauna and flora, represented by forms which can endure strongly diluted water and which no doubt lived principally in the saltiest bottom layers: *Portlandia* (*Yoldia*) *arctica*, a few foraminifera, *Phoca groenlandica*, *Cottus quadricornus*, *Gammaracanthus loricatus*, *Idothea entomon*, etc., and a few diatoms.[18] Portlandia was represented by a stunted form indicative of too high temperature and too diluted water. It was limited to the Mälar depression and lived close to the receding ice border. In the Stockholm region it existed for less than 100 years.[19] Consequently, it is unfortunate to distinguish, as Munthe has, a stage in the history of the Baltic as "Yoldia time."

When and by which way some marine forms found at Kalmar, in southern Sweden, immigrated,[20] and what rôle the connection of the Baltic with the White Sea via Ladoga and Onega played, seems to be too little known to be discussed.

As Scandinavia underwent a mighty upheaval the central Swedish sounds grew shallow, and the inflow of brackish water became less and less. By storms and circulation the brackish water was gradually brought up into the upper water layers and thence carried out to sea. Finally, during Ancylus time, the Baltic, even in the central Swedish region, became practically fresh.

The highest salinity of the Baltic, reached during the Littorina subsidence, was, as far as known, synchronous with the one time when both the Darsser Schwelle and the threshold in the southern Öresund lay so deep that salt undercurrents could normally pass across them. The Fehmarn Belt then stood at about the same level as now, or 18 meters deep, while the southern Öresund lay about 5 meters lower than now, i.e. was 13 meters deep. The water outside the threshold, in the Cattegat, was at that time, as shown by the subfossil molluscan fauna, salter than during any other late-Quaternary phase and considerably warmer than at present. Its high temperature and relatively low gravity was, probably, an essential reason for its effective mixing with the Baltic water.

When the Öresund region and the Danish peninsula rose, the salinity of the Baltic slowly decreased to its present percentage.

So it seems quite possible that the surface layers and the main mass of the Baltic during Ancylus time consisted of fresh water, even though there had been connection with the ocean during most of the time since the Danish Islands became free of ice. The transgression of Ancylus time within the Baltic can be explained by subsidence of land instead of by a rising of the water within a closed basin during a mighty and long-continued upheaval and tilting of the land. This view is directly supported by recent observations in western Sweden. At several points around lake Vänern, Von Post[21]

[18] See H. Munthe: Studies in the Late-Quaternary History of Southern Sweden, *Geol. Fören. Förhandl.*, Vol. 32, 1910, pp. 1197–1293; reference on p. 1236. Stockholm.

[19] Gerard De Geer: Finiglaciala Yoldia-relikter, *Geol. Fören. Förhandl.*, Vol. 35, 1913, p. 307. Stockholm.

[20] See Munthe, *op. cit.*, p. 1235.

[21] Lennart von Post: Ett finiglacialt granfyrd i södra Värmland, *Geol. Fören. Förhandl.*, Vol. 40, 1918, pp. 19–25. Stockholm.

has found an old shore line which undoubtedly corresponds to the limit of transgression in the Baltic region during Ancylus time and thus proves that the Ancylus transgression was due to a sinking of land. In the Christiania region and in Bohuslän there are similar evidences of a subsidence contemporaneous with the Ancylus transgression.

Changes of Level in the Baltic Basin

Region South of the Isobase of Zero

The South Baltic and North Germany, south of the isobase of zero, probably stood highest shortly after they were relieved of the ice. As has been explained (p. 603), the exact elevation is unknown but was probably more than 35 meters above the present. Since the withdrawal of the ice North Germany seems to have undergone an almost uninterrupted slow subsidence, until the present level was reached at the climax of the Littorina submergence.

Central Baltic Region

It seems evident that similar changes in level took place simultaneously in western and eastern Sweden. Western Sweden, lying on the sea, affords the decisive evidence as regards the direction of the movements.

In Bohuslän the following changes of level seem to have taken place.[22] When the ice uncovered the coast and the marine limit was recorded, an intense and extensive uplift was already in progress. The elevation was followed by subsidence in late goti-glacial time, i.e. when the ice receded south of lake Vänern. At the end of the goti-glacial and beginning of the fini-glacial epoch the region once more was rising. This second emergence was interrupted by a fini-glacial sinking. During the latter part of the fini-glacial epoch the land rose for a third time, only to undergo a new submergence in early post-glacial time. After a fourth subsidence (Tapes submergence) the tract finally rose to its present level, which was reached at the beginning of the Iron Age, or about 500 B. C.[23]

The late goti-glacial subsidence is that one observed by De Geer[24] at Kapellbacken, Uddevalla, but dated by him wrongly, I think, as fini-glacial. The fini-glacial submergence here recognized is new. The early post-glacial subsidence has been recognized for some time in southeastern Norway but is new for Bohuslän. The Tapes submergence has long been known.

As pointed out, all these oscillations should have had their parallels in eastern Sweden, in the Central Baltic region.

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[22] Ernst Antevs: Senkvartära nivåförändringar i Norden, *Geol. Fören. Förhandl.*, Vol. 43, 1921, pp. 642–652 Stockholm.

[23] Otto Frödin: En svensk kjökkenmödding, *Ymer*, Vol. 26, 1906, pp. 17–35; reference on p. 33.

[24] Gerard De Geer: Quaternary Sea Bottoms in Western Sweden, *Geol. Fören. Förhandl.*, Vol. 32, 1910, pp. 1139–1195. Stockholm.

The goti-glacial subsidence has not yet been established within the Baltic, but we can expect to find it registered in northern Småland and southern Östergötland.

The fini-glacial submergence has also been proved on Mt. Billingen[25] and at Karlsborg on lake Vattern.[26] To this subsidence should be attributed, probably, also the well-marked shore line in southern Finland which Ramsay[27] has interpreted as the marine limit after the drainage of the Baltic ice lake at Billingen. This view seems to be supported by a newly discovered fact. At the northern end of Billingen Lundqvist[28] determined the limit of the Baltic ice lake at a height of about 149 meters, the marine limit at 132 meters, and the fini-glacial limit at 117–119 meters. The difference in the level between the Baltic and fini-glacial limits is, consequently, 30–32 meters; and that between the marine and fini-glacial ones 13–15 meters. At Karlsborg the Baltic limit lies at 153[29] and the fini-glacial at 118–123 meters.[30] The difference of level is 30–35 meters. On the inner Salpausselka in southern Finland Ramsay[31] found well developed shore lines, which he interprets as the marine limit, 31–34 meters below the limit of the Baltic ice lake; and a little north of the Salpausselkä he found other terraces, in his opinion marking an interruption in the drainage of the ice lake, about 12–13 meters above the shore lines just mentioned. Thus Ramsay's "marine limit" seems to be better conceived of as the fini-glacial limit, and his less developed terraces as the marine limit after the drainage.

The early post-glacial subsidence seems to be identical with the Ancylus transgression, which, I think, is now fully proved to be due to subsidence of land and which may be early post-glacial instead of fini-glacial, as has generally been assumed.[32]

The Tapes submergence on the west coast was contemporaneous with the Littorina subsidence in the Baltic.

Southern Baltic North of the Isobase of Zero

The changes of level in southernmost Sweden and eastern Denmark have not yet been satisfactorily worked out. Thus, we do not know how many oscillations there have been nor what limits they have reached. However, it seems likely that the region has undergone all the oscillations that have occurred in Bohuslän and the central Baltic, and possibly earlier ones.

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[25] G. Lundqvist: Den baltiska issjöns tappning, *Geol. Fören. Förhandl.*, Vol. 43, 1921, p. 385. Stockholm. Also oral information by Dr. Simon Johansson.

[26] Lundqvist, *op. cit.*, p. 385.

[27] Wilhelm Ramsay: De s. k. marina gränserna i södra Finland, *Fennia*, Vol. 40, No. 7, 1917. Helsingfors. *Idem: Geol. Fören. Förhandl.*, Vol. 43, 1921, p. 495. Stockholm.

[28] Lundqvist, *op. cit.*, p. 382.

[29] Munthe, *op. cit.*, Pl. 47.

[30] H. Hedström: Om ändmoräner och strandlinjer i trakten af Vaberget, *Sveriges Geol. Unders.*, Ser. C, No. 188, 1901. Stockholm. Interpretation Lundqvist, *op. cit.*, p. 385.

[31] Ramsay, *Geol. Fören. Förhandl.*, Vol. 43, 1921, p. 495. Stockholm.

[32] Antevs, Senkvartära, p. 652.

Central Region of the Upheaval District

When the peripheral districts were rising the more central ones were still depressed, nor do the later oscillations seem to have been contemporaneous in the whole district of upheaval. Thus, it is generally assumed that undulating movements of the crust of the earth advanced from all sides toward the center of the Scandinavian peninsula. Before reaching there, however, they seem to have lost themselves in an intense and unbroken elevation.[33]

[33] R. Lidén: Om issvsmältningen och den postglaciala landhöjningen i Ångermanland, *Geol. Fören. Förhandl.*, Vol. 33, 1911, pp. 271–280. Stockholm.

Idem: Geokronologiska studier öfver det finiglaciala skedet i Ångermanland, *Sveriges Geol. Unders.*, Ser. Ca, No. 9, 1913. Stockholm.

THE EARTH'S CRUST AND ISOSTASY

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It would be interesting to trace the different views which have been held, throughout past ages, regarding the condition of the outer and inner portions of the earth. For the purposes of this article it suffices to say that the belief that there is some difference between the outer portion and the inner portion of the earth and, therefore, a distinct crust, has always been maintained and is even today well fixed in our minds.

The earth's crust was originally pictured as a thin veneer floating on a molten interior. This conception must be modified to agree with modern results based upon accumulated geophysical observations and measurements made during the last few decades. For example, the observations made by seismologists, respecting the time of transmission of earthquake waves, prove that the interior substance is solid and not molten. Again, the observations upon the earth's tides as caused by the sun and moon indicate very clearly that the interior of the earth is not molten. It has been computed by investigators in seismology and tides that the earth, as a whole, has at least the rigidity of steel.

DEFLECTIONS OF THE VERTICAL

It has been known for a long time that whenever an astronomic station connected with a net of triangulation is located near a mountain range, a large deflection of the vertical occurs. The *deflection of the vertical* is a term applied to the deviation of the plumb line (to which all astronomic observations are referred), from the normal to the mean surface of the earth or the ellipsoid. The triangulation, being a direct measurement made with instruments of precision and by highly skilled technicians, will carry geographic positions throughout the net with a very high degree of accuracy; but, when this triangulation is connected with astronomic stations which are influenced by mountains or other elevated masses of land, it will be found that the latitudes and longitudes carried by the triangulation will differ materially from the latitudes and longitudes determined by the astronomic observations.

What is the reason for this discrepancy? It is a well-known fact that a mountain mass attracts a particle just as the earth as a whole does. The attractions of the mountain mass and the earth are in proportion to their respective masses and inversely proportional to the squares of the distances of their centers from the particle on which they are acting. At-

tempts were made many years ago to correct the astronomic observations for the effect on the plumb line of the masses above sea level. The effect of applying the correction for the attraction of the mountain masses to the astronomic determinations was to make the difference between the astronomic and the geodetic positions have the opposite sign, although making it somewhat smaller numerically.

Archdeacon Pratt, in his geodetic investigations about the middle of the last century,[1] was forced to the conclusion that the mountains did not attract the plumb line to the extent that their masses and distances from the station would seem to justify one in believing. He expressed the view that the mountains acted as if there were vast voids below them. Of course, Pratt did not believe that there are actual voids; but he did believe that there is lighter matter (commonly called a "deficiency" of matter) under the mountains which, to a certain extent, neutralizes the attractive effect of the mountains themselves.

This idea had been hinted at by other writers[2] before Pratt but not in such a definite way, and it was some years before the idea gained much favor with geologists and geophysicists.

One of the early advocates of the theory that there is a deficiency of matter under mountain areas and that there is an excess of material or density under the oceans, was Major C. E. Dutton, of the U. S. Geological Survey. In 1889, in a paper before the Philosophical Society of Washington entitled "On Some of the Greater Problems of Physical Geology,"[3] he discussed at length the condition of the outer portion of the earth and strongly advocated the theory that at some depth below sea level there is a state of equilibrium or of equal pressure in the earth's crust. He believed that unit columns of the outer portion of the earth exert the same pressure on an imaginary surface at an unknown depth regardless of whether the columns are under the oceans, the coastal plains, the plateaus, or the mountains. Dutton used the term "Isostasy," meaning equal pressure, for this condition of crustal equilibrium.

Dutton's views on the subject of isostasy had a very stimulating influence on the geologists and physiographers of his time. Among others who wrote on the same subject were Gilbert, McGee, Putnam, Ransome, and

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[1] J. H. Pratt: On the Attraction of the Himalaya Mountains, and of the Elevated Regions Beyond Them, Upon the Plumb-Line in India, *Phil. Trans. Royal Soc. of London*, Vol. 145, 1855, pp. 53–100.

Idem: On the Influence of the Ocean on the Plumb-Line in India, *ibid.*, Vol. 149, 1859, pp. 779–796.

Idem: On the Deflection of the Plumb-Line in India Caused by the Attraction of the Himalaya Mountains and of the Elevated Regions Beyond; and Its Modification by the Compensating Effect of a Deficiency of Matter Below the Mountain Mass, *ibid.*, Vol. 149, 1859, pp. 745–778.

Idem: On the Constitution of the Solid Crust of the Earth, *ibid.*, Vol. 161, 1871, pp. 335–357.

[2] [Pierre] Bouguer: La figure de la terre, déterminée par les observations de Messieurs Bouguer et de la Condamine, etc., Paris, 1749, p. 364.

M. Petit: Sur la densité moyenne de la chaîne des Pyrénées et sur la latitude de l'Observatoire de Toulouse; *Comptes Rendus de l'Acad. des Sci. [de Paris]*, Vol. 29, 1849, pp. 729–734.

R. G. Boscovich, De Litteraria Expeditione per Pontificiam Ditionem, Rome, 1755, p. 475; quoted in Isaac Todhunter: A History of the Mathematical Theories of Attraction and the Figure of the Earth, from the Time of Newton to That of Laplace (2 vols., London, 1873), Vol. 1, p. 313.

[3] *Bull. Philos. Soc. of Washington*, Vol. 11, 1892, pp. 51–64.

Willis.[4] Putnam was the first investigator to attempt to give a quantitative measure of the extent to which the earth's outer portion is in equilibrium.

In the early part of the present century Hayford began his remarkable isostatic investigations while connected with the U. S. Coast and Geodetic Survey, in charge of geodetic operations. He used the connected triangulation of the United States and numerous astronomic latitudes, longitudes, and azimuths in a study of the effect of the theory of isostasy, or the isostatic condition of the earth's crust, on the figure of the earth. Hayford issued two reports covering the details of those investigations,[5] which outline the methods employed by him and the conclusions reached. In addition to these reports, he has written a number of articles for the scientific press, dealing with the results of his investigations.[6]

In 1909 I was stationed at the office of the Coast and Geodetic Survey, Washington, D. C., as assistant to Hayford in the Division of Geodesy, and together we made a study of the effect of the isostatic condition of the earth's crust on the intensity of gravity.[7]

Important investigations, dealing with the earth's crust and the theory of isostasy,[8] have been made in India by the officials of the Trigonometrical Survey of India. It may be said that the work in India and that in the United States supplement and confirm each other.

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[4] G. K. Gilbert: The Strength of the Earth's Crust [Abstract], *Bull. Geol. Soc. of America*, Vol. 1, 1889, pp. 23–27.

Idem: Notes on the Gravity Determinations Reported by Mr. G. R. Putnam, *Bull. Philos. Soc. of Washington*, Vol. 13, 1895–99, pp. 61–75.

W J McGee: The Gulf of Mexico as a Measure of Isostasy, *Amer. Journ. of Sci.*, No. 261, Ser. 3, Vol. 44, 1892, pp. 177–192.

G. R. Putnam: Relative Determinations of Gravity with Half-Second Pendulums, and Other Pendulum Investigations, *U. S. Coast and Geodetic Survey Rept. for 1894*, Appendix I, pp. 7–50; and G. K. Gilbert: A Report on a Geologic Examination of Some Coast and Geodetic Survey Gravity Stations, *ibid.*, Appendix I, pp. 51–55.

G. R. Putnam: Results of a Transcontinental Series of Gravity Measurements, *Bull. Philos. Soc. of Washington*, Vol. 13, 1895–99, pp. 31–60.

F. L. Ransome: The Great Valley of California: A Criticism on the Theory of Isostasy, *Univ. of California Publs. in Geology*, Vol. 1, 1893–96, pp. 371–428.

Bailey Willis: The Mechanics of Appalachian Structure, *Thirteenth Ann. Rept., U. S. Geol. Survey, 1891–92, Part II, Geology*, pp. 237–281.

[5] J. F. Hayford: Figure of the Earth and Isostasy from Measurements in United States, U. S. Coast and Geodetic Survey, Washington, D. C., 1909. (No number.)

Idem: Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy, U. S. Coast and Geodetic Survey, Washington, D. C., 1909. (No number.)

[6] J. F. Hayford: The Geodetic Evidence of Isostasy, with a Consideration of the Depth and Completeness of the Isostatic Compensation and of the Bearing of the Evidence Upon Some of the Greater Problems of Geology, *Proc. Washington Acad. of Sciences*, Vol. 8, 1906, pp. 25–40; *idem:* The Earth, a Failing Structure, *Bull. Philos. Soc. of Washington*, Vol. 15, 1907–10, pp. 57–74.

[7] J. F. Hayford and William Bowie: The Effect of Topography and Isostatic Compensation Upon the Intensity of Gravity, *U. S. Coast and Geodetic Survey Special Publ. No. 10, Geodesy*, Washington, D. C., 1912.

William Bowie: Effect of Topography and Isostatic Compensation Upon the Intensity of Gravity, *U. S. Coast and Geodetic Survey Special Publ. No. 12, Geodesy*, Washington, D. C., 1912.

Idem: Investigations of Gravity and Isostasy, *U. S. Coast and Geodetic Survey Special Publ. No. 40, Geodesy*, Washington, D. C., 1917.

[8] See especially S. G. Burrard: Investigations of Isostasy in Himalayan and Neighbouring Regions, *Survey of India Professional Paper No. 17*, Dehra Dun, 1918. See also papers by Colonel Burrard, "A Brief Review of the Evidence Upon Which the Theory of Isostasy Has Been Based," *Geogr. Journ.*, Vol. 56, 1920, pp. 47–59; "On the Origin of Mountain Ranges," *Geogr. Journ.*, Vol. 58, 1921, pp. 199–218; and the review by A. Mosley Davies, "The Problem of the Himalaya and the Gangetic Trough," *Geogr. Journ.*, Vol. 51, 1918, pp. 175–183.

Some general conclusions from the isostatic investigations in the United States and India are:

1. The earth's crust is in a state of practically perfect isostatic equilibrium.

2. The depth to which the isostatic compensation extends is not and cannot be correctly determined, nor is it possible to determine in what manner isostatic compensation is distributed, whether uniformly with respect to depth or in some other manner.

3. If it is assumed that the isostatic compensation is uniform with respect to depth and is complete within a certain depth, then the most probable limiting depth is about 60 miles.

4. It is impracticable or impossible to determine whether the isostatic compensation is directly under a topographic feature to the extent that single mountain peaks are compensated within the column directly under them.

5. It has been determined, however, that the isostatic compensation of a topographic feature is probably not distributed horizontally to distances as great as 100 miles from the feature.

6. The isostatic compensation of topographic features is so complete that the deflections of the vertical are only approximately 10 per cent of what they would be if the land masses were excess loads on the earth's crust. Also the isostatic condition of the earth's crust is such that the gravity anomalies, that is the differences between the observed and the computed values for the intensity of gravity, are on an average not more than 15 per cent as large at stations at high elevations, as they would be on the theory that the earth's crust is rigid.

The above conclusions are in every way justified from the exact measurements that have been carried on in the United States and, to a limited extent, in other countries; though specific attention should be directed to numbered paragraph 3 above and to the assumptions preceding the concluding estimate of limiting depth of compensation. Such assumptions can of course be made the basis of further investigations that may modify the result.

There are other conclusions which seem to be justified, and some of them will be discussed below. It should not be understood that they are the only ones that can be reached; but they seem in the present state of knowledge to be logical, and they do not conflict with the existing geodetic and geophysical data.

The Rigidity of the Earth's Crust

The earth's crust must have considerable rigidity in order to maintain the irregular relief of the earth. It is true that each unit column of the earth's crust, or isostatic shell, as it has been very aptly called by Bailey Willis, has the same mass as any other unit column, but we must not think

in terms of columns of very small cross section. It seems safe to assume a unit cross section for compensated areas of 70 miles square, the approximate area of a square degree at the equator.

What the geodetic observations and investigations have done is really to measure indirectly the differences in weight of the masses in the various unit columns of the earth's crust, and these columns have been found to be remarkably near each other in the amount of their masses.

If the earth's crust were not rigid to a certain extent, mountain masses would overflow marginal areas of lower elevation; likewise, the material of a continent would overflow the ocean bottom. If there were no rigidity in the earth's crust, this process would continue until all irregularities in

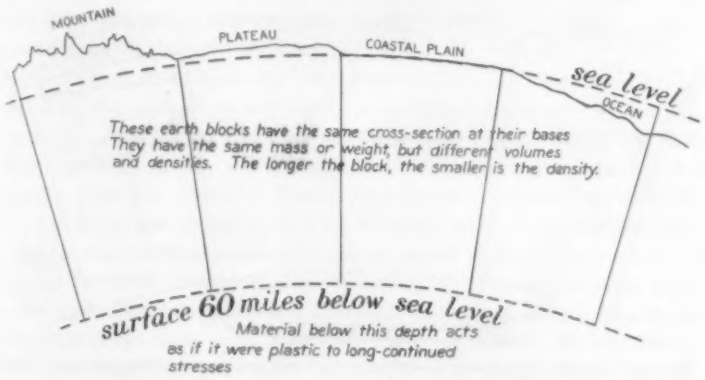
MOUNTAIN
PLATEAU
COASTAL PLAIN
sea level
OCEAN
These earth blocks have the same cross-section at their bases
They have the same mass or weight, but different volumes
and densities. The longer the block, the smaller is the density.
surface 60 miles below sea level
Material below this depth acts
as if it were plastic to long-continued
stresses

FIG. 1—Probable limiting depth of isostatic compensation.

the surface of the earth were smoothed out. There is in reality a tendency toward overflow, just as there is a tendency for any structure to collapse, but the rigidity (combined with the strength) of the material keeps it in place. Apparently the rigidity of the earth is such that this flattening out will never occur. However, the resistance of the earth's crust, while great enough in a horizontal direction to resist the flattening of the earth's surface, is not great enough to withstand the vertical stresses developed by the erosion of matter from high ground and its deposition in low areas.

Enormous loads of material are taken from mountain areas and deposited in valleys or at the mouths of rivers. If the earth's crust were of such rigidity and offered such resistance to vertical forces as to hold up the sedimentary material, this fact would be easily discovered from the geodetic data on the deflections of the vertical and the intensity of gravity. This question has been very carefully considered, and it has been found that areas of sedimentation are as nearly in a state of perfect isostatic equilibrium as more quiescent areas, geologically speaking.

As another evidence of the inability of the earth's crust to withstand a vertical stress we may cite the case of a mountain mass from which thousands

of feet of material have been eroded in recent geologic times. If the mountain were in isostatic equilibrium before the erosion began, then it certainly would not be in equilibrium at the present time if no upward movement had occurred at the base of the mountain column to offset the loss of material by erosion at the top. The mountain mass is *now* in equilibrium, and therefore as erosion progressed there must have been *in the past* a transfer of material to the column under it.

We may accept the fact that areas of sedimentation and areas of erosion are in substantial equilibrium not only in the United States but in other countries. Wherever isostatic investigations have been made the data confirm this conclusion.

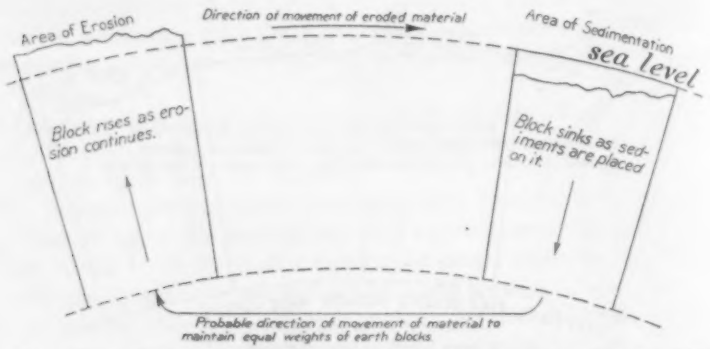
Area of Erosion
Direction of movement of eroded material
Area of Sedimentation
sea level
Block rises as erosion continues.
Block sinks as sediments are placed on it.
Probable direction of movement of material to maintain equal weights of earth blocks

FIG. 2—The mode of compensation between a rising column in an area of erosion and a sinking column in an area of sedimentation.

ZONE OF FLOW

As the earth's crust is in isostatic equilibrium we must conclude that there is a transference of material horizontally from areas of sedimentation to areas of erosion. It is only in this way that the isostatic balance can be maintained. Assuming that horizontal movements maintain that balance, we are forced to conclude that the material at some point below the crust of the earth is of a yielding nature, much more so in fact than any matter near the surface of which we have knowledge.

Seismologic observations and those connected with the determination of earth tides, prove conclusively that the earth's material at all depths is solid. The response of the solid crust to the tide-producing forces of the sun and moon is only a fraction of what it would be if the earth were thoroughly plastic. The seismic waves that travel to a distant observer from an active earthquake center pass by a direct route through the earth, and this would not be the case if the crustal matter were liquid or if it were plastic to short-time stresses.

We have apparently to conclude that there is a zone below the isostatic shell, or the crust of the earth, within which the matter is rigid to stresses

continued over a short period, such as the tide-producing forces of the sun and the moon, but is plastic to the long-continued stresses which result from an unloading of one part of the isostatic shell and the loading of another. When we speak of long-continued stresses we have in mind stresses that last for thousands of years, that is, we are speaking in geologic time rather than in human time.

The condition of the material of the earth below the zone of flow need not be considered for our present purposes. When we speak of a zone of flow we are simply trying to visualize the condition of affairs below the earth's crust involved in the transference of material to maintain the isostatic balance, and we do not necessarily imply that this zone has limited thickness. It may be a thin zone, a thick zone, or one that extends throughout what may be called the nucleus of the earth, the nucleus being that portion of the earth below the isostatic shell.

It seems logical to assume that the flow of material, due to transference of material at the surface of the earth, must be at or below the base of the isostatic shell. In the first place the determination of the depth of the isostatic shell, or that depth within which the isostatic compensation exists, presupposes that the material above that depth is somewhat different in its behavior from the material below. If there were a transference of material within the isostatic shell, then it is rather difficult to see how there could be an isostatic compensation occurring within this moving material. If the isostatic compensation were in material that is plastic enough to move horizontally, then surely this plastic material would assume a condition of hydrostatic equilibrium within a very short time, geologically speaking. The material could not be like the outer portion of the earth, which is able to withstand the tendency of gravity to flatten out the irregularities of the surface.

The second objection to having the isostatic adjustment of flow take place above the depth of compensation is that there is an equality of pressure at the depth of compensation. At that depth columns of like cross section balance each other in pressure or weight. Now, when there is a transference of material from one column to another at the surface and the corresponding isostatic flow begins, we certainly have to go practically to the depth of compensation in order to find the hydrostatic pressure to make the material flow from the short column—the one subjected to sedimentation—to the mountain column from which the sediments have been eroded.

If we assume an isostatic flow only a few miles below the surface, should we not be trying to move material from a light block to a heavy one? In a plane of reference, say 10 miles below sea level, we might have the base of a column 11 or 12 miles in length under the area of erosion (mountains) and one of only 10 miles in length under the area of sedimentation (plains). It is evident that at a depth of 10 miles the stress difference will be from the mountain area towards the plains area. Only when erosion on the one

hand and sedimentation on the other have been so great as to cause the plains section of the crust to overbalance the weight of the mountainous crust could we expect to have flow from the plains area to the mountain area. The flow resulting would take place at whatever depth the pressure is greater under the sediments than under the mountains from which the material was eroded.[9] What is the depth at which this pressure difference is expressed in flow? Let us turn to this as the next item of enquiry. It is easy to compute at what depth the weight of a column on which the sediments have been placed will equal that of the column under the area that has been eroded if the compensation is assumed to be uniformly distributed

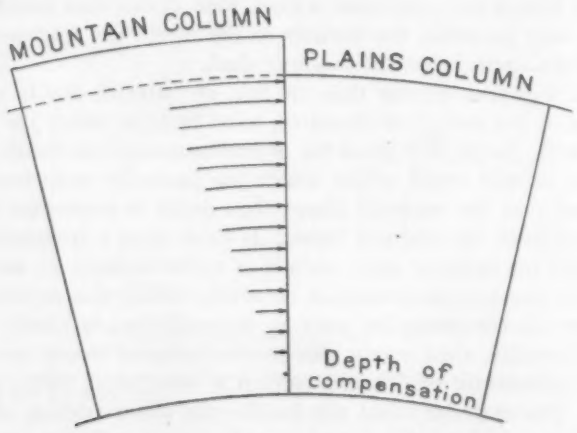

FIG. 3—Depth of compensation between mountain and plains columns when transference of material from one to the other, at the surface, is just beginning.

with regard to depth. The greater the transference of matter before isostatic adjustment has begun,[10] the nearer the surface will be the depth at which the pressures of the columns will be equal. It seems reasonable to assume that the amount of material which can be deposited before isostatic adjustment begins is quite small, less than 1,000 feet in thickness. Therefore, if we hold to the view that 1,000 feet of material over a rather extended area is the maximum that will escape isostatic compensation, then we shall find that the depth at which the flow must take place is greater than 50 miles.

This question of the depth at which the isostatic adjustment takes place is a most important one from a physiographic standpoint. If the flow occurs as a deep-seated phenomenon, we must conclude that the configuration of the earth's surface between the area of erosion and the area of sedimenta-

[9] This idea is brought out by Hayford in his article entitled, "The Relations of Isostasy to Geodesy, Geophysics and Geology," *Science*, Vol. 33 (N. S.), 1911, pp. 199–208.

[10] Undoubtedly the isostatic adjustment lags somewhat behind the transference of matter at the surface.

tion has little or no relation to the material moving horizontally at or below the lower surface of the crust. It is not probable that any wavelike distortion of an extensive character can be due to this slow movement of the plastic materials below the isostatic shell. If the flow were close to the earth's surface, say within a few miles, then undoubtedly there would be an effect on the configuration of the earth's surface by the horizontal movement, just as the flow of molten lava will greatly distort the cooler solid lava which floats on it.

It is probable that in an alluvial plain there is at least some horizontal movement of material near the surface, possibly within a mile, due to stress

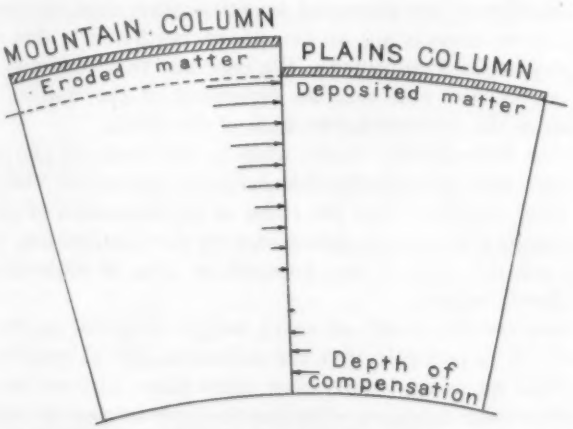

FIG. 4—Depth of compensation between mountain and plains columns after the transference of eroded material at the surface has continued without compensation by deep-seated flow. This depth is taken to exceed 50 miles for a surface accumulation of eroded material 1,000 feet thick.

differences in the unconsolidated sediments. But we should expect no movement from one block toward another of greater mass.

It is certain that there cannot be a flow of material near the surface from a narrow mountain valley back toward an adjacent mountain slope from which material is being eroded and deposited in the valley. The stress difference in the upper portion of the isostatic shell is always from the mountain toward the adjoining valley. It is very improbable that columns of small cross section are individually in isostatic equilibrium and that a small valley column could sink throughout its entire length and uplift a second small column under the adjacent mountain side. The rigidity of the material of the isostatic shell would certainly prevent such movements. The recently published views of Tandy on this subject appear to me to be in opposition to the plainest facts of physiography and geodesy.[11]

[11] E. A. Tandy: The Circulation of the Earth's Crust, *Geogr. Journ.*, Vol. 57, 1921, pp. 354–376.

Mountain Systems and Oceans Not Maintained by Rigidity of Earth's Crust

Modern investigations in isostasy lead to the definite conclusion that differences of elevation between mountain masses and continents on the one hand and plains and oceans on the other are not due to the strength of the earth's crust, but that they express the deficiency of matter under the elevated areas and the excess of mass under the depressed ones.

It should be clearly borne in mind that the continents compensate the deficiency of density under them and that the oceans compensate the excess of density below their bottoms. In other words, the land masses and the oceans are the effect of the abnormal densities rather than the cause.

If the mountain mass is not an extra load, neither is it due to regional horizontal pressure and movement. We conclude that it is due to vertical forces and movements and that an expansion of the matter under the mountain area is the most probable cause of the uplift.

The question immediately arises, what is the cause of the expansion? This is a matter that is decidedly speculative or theoretical. In two recent articles[12] I have suggested that the cause of the expansion of the material of a column under a mountain system may be due to a heating of material forming this column when it was beneath an area of sedimentation and sinking into hotter regions.

As sediments are deposited, an extra weight is added at the plane of compensation. It is probable that the sediments are so small in mass in some places that no vertical movement takes place; but we know that in other places enormous amounts of sediments have formed, as indicated by the exposed strata in mountainous regions. Nearly all mountain areas were at one time areas of heavy sedimentation, and the sediments were deposited in shallow water or not much above sea level. This process of heavy sedimentation is now going on at the mouth of the Congo, in the Indo-Gangetic region, and about the La Plata estuary.

The sediments from which mountains were formed were in some cases 30,000 feet or more in thickness. Let us assume that in some particular case this depth of sediments was six miles. As the sediments were deposited, the matter in the crust under them was forced down into regions that were hotter; and, when the base on which the sediments had been placed was depressed to the extent of six miles, every portion of the column from the base of the sediments to the depth of compensation was subjected to a temperature that was hotter by the change in temperature for a difference in depth of six miles. This change in temperature is not known; but, if the temperature gradient is anywhere near what it is for the first mile of the earth's crust, the change is very great.

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[12] William Bowie: The Relation of Isostasy to Uplift and Subsidence, *Amer. Journ. of Sci.*, Ser. 5, Vol. 2, 1921, pp. 1–20.

Idem: Some Geologic Conclusions from Geodetic Data, *Proc. Natl. Acad. of Sci.*, Vol. 7, 1921, pp. 23–28.

It is probable that a surface of equal temperature, termed "geoisotherm," will be somewhat depressed as the sediments are being placed on the surface and the column is sinking. Later the geoisotherm will rise to its normal position. In this process the material under the sedimentary area will become much hotter than it was before sedimentation began, and it is my view that physical or chemical changes or both will occur which will expand the material of the column and thus elevate the surface to form a mountain system.

This vertical movement of material would undoubtedly be accompanied by the development of inclined forces, and in some cases even horizontal ones, which would move the material in such directions as to cause the distortions that may be observed in an uplifted area. The base of a moun-

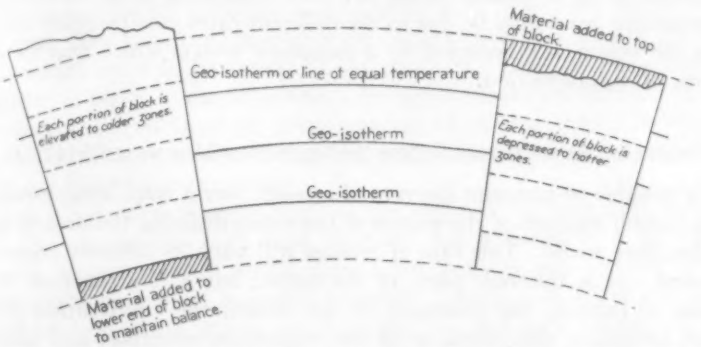
Material added to top of block.
Geo-isotherm or line of equal temperature
Each portion of block is elevated to colder zones.
Geo-isotherm
Each portion of block is depressed to hotter zones.
Geo-isotherm
Material added to lower end of block to maintain balance.

FIG. 5—Changes of temperature in rising and sinking columns to suggest the deforming effect of expansion in a sinking mass under an area of sedimentation.

tain system is usually quite large, the Appalachian system being considered as approximately 200 miles in width by 1,000 or more miles in length. This is an area quite large enough for the development of horizontal and inclined forces due to the uplift of material in response to changes in density.

It is undoubtedly true that sediments are deposited in a very irregular way. Some part of a region of sedimentation that eventually will become the location of a mountain system will naturally receive most of the sediments, but as sedimentation progresses the surface of this area may become higher, by the building-up process, than contiguous areas. When this has occurred sedimentation is then shifted to one of the lower areas, and so on throughout the history of the region. Since sedimentation takes place in different parts of the area at different times and at different rates, we should expect a large amount of distortion of the sedimentary strata during the process of subsidence under the added loads.

After sedimentation has ceased in a given region and possibly after a long period of quiescence an upward movement may occur resulting in the formation of a mountain system. During the uplift there is probably a very irregular movement due to variations in the resistance of the recently

deposited sedimentary matter and of the material of the crust below it. The different resistances would, presumably, permit the uplift to occur more rapidly in one part of the region than in another. When the uplift in one area had progressed to a point where resistance to further uplift on account of the weight of the uplifted material was greater than in an area in which uplift had been retarded, vertical movement would probably take place in the latter area.

There would be a great force acting to restrain uplift near the edges of a rising column, for it is probable that the uplift would be confined largely to the column on which sedimentary material had been placed. Probably the greatest distortion of strata would occur near the edges of the area of uplift. Thus, much of the distortion of strata which in the past has been attributed to the horizontal thrust of forces originating in the areas outside the mountain areas may be due to the different rates of subsidence and uplift in the region now occupied by a mountain system which was formerly an area of sedimentation.

Isostatic Adjustment Tends to Maintain Mountain Systems

It is possible to compute the rate of erosion over a large area, especially where careful analysis of the waters of the rivers draining the area in question has been made. This rate of erosion will vary in different parts of a continent and in different parts of the world; but it is a function of the amount of rainfall, the steepness of the slopes, the composition of the surface materials, the character of the vegetation covering, and possibly other conditions. It can be safely said that the flattening process is a very slow one and, even if there were no further uplifts due to expansions of columns of the isostatic shell, the time necessary to wear down a mountain system would be very great, and mountains on the continents would remain for a long time. But it is also very probable that the expansion of columns under areas heavily sedimented will continue in the future and form new mountain systems.

Geodetic researches indicate very clearly that mountain columns must have been maintained in isostatic equilibrium throughout the erosional period. It might be thought that when 100 feet of material has been eroded from a mountain area the mountain would be raised vertically by the same amount to maintain equilibrium. But the material that is brought into the column under the mountain area by isostatic adjustment is undoubtedly denser than the material eroded from the surface, and, therefore, not so great a volume is needed to maintain the isostatic balance. It is probable that the difference in density of the surface material and that at a depth of about 60 miles is as much as 10 per cent. When 100 feet on an average is eroded from an area, the disk of material brought into the column at its base is, on this assumption, only 90 feet in thickness, the difference in thickness of the two disks being due to the difference in density of 10 per cent.

Therefore, on the assumption that compensation at the isostatic level is taking place without delay, as an area is eroded 100 feet we should expect its average elevation to be 10 feet lower than before the erosion began. Similarly, if 1,000 feet of material is eroded, the average elevation should be reduced by 100 feet; and if 10,000 feet is eroded, the average elevation should be reduced 1,000 feet; and so on.

The process of gradually decreasing the average elevation of an area accounts for the presence of sedimentary material tens of thousands of feet in thickness which must have been eroded from mountain systems of moderate horizontal dimensions. We can see that to reduce to sea level a mountain system of an average elevation of 5,000 feet, approximately 50,000 feet must be eroded from its area.

This continued uplift of the material of a mountain during erosion probably accounts for the exposure of an igneous core. From the Rocky Mountain area there have been eroded many thousands of feet, and in places the sedimentary material has been entirely removed. This also has occurred in a number of places in the Alps, where the highest peaks are formed of abyssal igneous rocks. Without the great amount of erosion that is involved in wearing down a mountain system the originally deep-seated igneous rocks could not have been uncovered.

Does it not seem possible that, as the uplift of the mountain continues after the system has once been elevated, there should be a tremendous amount of distortion of strata due to the isostatic adjustment? I think this vertical movement accounts for much (though not all) of the rupture and distortion of the strata which in the past has been considered as the result of regional forces of different origin acting horizontally in the earth's crust.

The mountains will certainly be gradually, although very slowly, base-leveled as the results of erosion, in spite of the tendency towards approximate maintenance at the original elevation by isostatic adjustment. The differential density between the eroded material and the material brought into the base of the column in response to isostatic adjustment will eventually leave a mountain system at a low altitude. This will occur, however, only after tens of thousands of feet of material have been eroded from the area, an amount wholly disproportional to the original elevation of the mountains.

Possible Cause of Subsidence

When a mountain area has been lowered 5,000 feet and base-leveled, all parts of the original column under the mountain area have been brought possibly from 8 to 10 miles closer to the surface of the earth than they were before erosion began. After the erosion period of a particular area is ended, then it would be expected that the material in the column, which had been brought up into colder regions, would lose some of its heat and that chemical or physical changes might occur that would tend to contract it. It is prob-

able that the geoisotherms, or surfaces of equal temperature, were bent upwards in the upward movement incident to the isostatic adjustment of the column and that these geoisotherms are gradually depressed to their normal depths after the active erosion of the surface of the column has ceased. As this cooling process goes on in the column under the former mountain area it is possible that the surface of the earth may be depressed to sea level or even below it. When this has occurred, then the area may again become one of sedimentation; and the process of depositing the sediments that may eventually be thrown up as a mountain system is started over again. It may be that mountain areas have been what may be called active regions for geological ages past and that there has been a succession of sedimentation, mountain uplift, base-leveling, repeated sedimentation, a second uplift, and so on. It is possible also that there are areas in which heavy sedimentation has never occurred and which have never been elevated into a mountain system or a high plateau.

Outstanding Problems

A number of problems will have to be solved before we know very much about the causes of the uplift of continents above the ocean level and the processes that are involved in the uplift of an area that was once at low altitude. For example we should like to know what caused the first irregularities in the surface of the earth. There must have been some areas higher than others in order that there could be initial erosion and transportation of material.

It is possible that there was an initial difference in the density of the material in different parts of the earth's crust causing large differences in elevation. It may be that the average elevation of the areas comprising the present continents has always been greater than the average elevation of the areas now occupied by oceans. This does not mean, however, that there have not been decided changes in the elevation of parts of the continents. At times parts of the continents have been under water and at other times many thousands of feet above sea level, forming mountain masses. Changes are continually taking place in the density of the materials in the isostatic shell which cause considerable changes in the elevations of affected areas. Large changes may have occurred in the elevation of the bottom of the oceans. In places mountains may have been formed reaching to the surface, and at other places there may have been a sinking of the bottom. Such changes must be the result of changes in density and must be due to changes in volume rather than in chemical composition. Dr. Henry S. Washington has been working on the matter of the relation of the general elevation of an area to the chemical density of its igneous rocks. He has found that the average density of these rocks occurring on continents is less than that of igneous rocks occurring on oceanic islands. It appears from his work that the chemical density of the material in the crust under the oceans is greater than that under the continents.

To point to another problem, it is of the greatest importance that an apparatus be perfected which will permit the accurate determination of gravity at sea. Much work could be done with such an apparatus at small expense, and the results would show very definitely whether the earth's crust under ocean areas is in the same state of equilibrium as under the land. In my opinion such observations will prove that isostatic adjustment is world-wide. The geodetic institutions of the countries of the world should carry on isostatic researches, using the accumulated data in the form of deflections of the vertical and the intensity of gravity which they now have at their disposal. Gravity observations should be made in many land areas of the earth which have not yet been explored so far as gravimetric surveys are concerned.

Much remains to be done, but the isostatic investigations of the past twenty years have shown that the earth's crust is in a state of equilibrium. This work has been done by the geodesist, and we must now look largely to the geologist to apply the knowledge gained by the isostatic investigations to the interpretation of the forces and movements which have brought about and maintained the isostatic equilibrium.

CONCERNING AERIAL PHOTOGRAPHIC MAPPING: A REVIEW *

By James W. Bagley

To the geographer, to the explorer, and to the pioneer interested in learning the character and resources of remote parts of the world the possibility of mapping before penetrating is like the short way to India and Cathay.

Mapping of Inaccessible Country

The application of this possibility in Morocco, where the French have the task of establishing order in a large area of country which is inhospitable both because of its character and the unfriendliness of the tribes, is discussed by Colonel Noirel. The method here employed for mapping is to establish points of control on the terrain occupied and to mark them with signals which can be identified on aerial photographs. Flying at great height directly over the marked points, two series of photographs are taken, one with a camera pointed downward and a second with a camera pointed obliquely toward the mountains. Though Colonel Noirel does not so state, it is supposed that the two cameras are joined rigidly together and that the relationship between the two chambers is carefully determined. The effect of this arrangement would be that the aerial positions and orientations of the photographs could be obtained from the "vertical" [1] photographs which embrace the targets, and afterwards directions and vertical angles taken from the oblique photographs would supply data to map the mountains. Topographic reconnaissance maps of the scale 1: 200,000 which were made in this fashion of country south of Taza have been used.

The method used by the French is undoubtedly feasible for mapping a narrow belt of absolutely inaccessible country of high mountains, but it is doubtful whether it will permit of extension over large areas of considerable

* H. Noirel: La topographie moderne et les applications de la photographie aux levés topographiques. Maps, diagrs., ills. *Bull. Bimestriel de la Soc. de Topographie de France*, Vol. 45, 1921, pp. 106–127. Paris.

C. G. Lewis and H. G. Salmond: Experiments in Aeroplane Photo Surveying. 53 pp.; diagrs. *Survey of India Professional Paper No. 19*. Dehra Dun, 1920. 3s. 11 x 8½ inches.

M. N. Macleod, comp.: Mapping from Air Photographs. 66 pp.; maps, diagrs., ills., index. General Staff, War Office, London, 1920. 4s. 13 x 8½ inches.

H. Roussilhe: Applications de la photographie aérienne aux levés topographiques de précision. Diagrs. *Annales Hydrogr.*, No. 703, Ser. 3, Vol. 1, 1917, pp. 81–176. Paris.

—— Rapport sur les études techniques effectuées in 1919 et 1920 sous la direction de M. H. Roussilhe. Reconstitution Foncière et Cadastre, Ministère des Régions Libérées, Paris, 1921.

—— The Use of Aerial Photographs in Topographic Mapping. 31 pp.; maps, diagrs., ills. *Air Service Information Circular No. 184*, Washington, D. C., 1921.

[1] During the World War it became customary in the armies of the United States and Britain to speak of aerial photographs which had been taken with the optical axis of the camera directed downward as "verticals." The French usually keep in mind the position of the negative in the camera and call them horizontal photographs.

depths such as the topographer maps at comparatively small scale on a reconnaissance trip of three months with pack train in much of our western mountainous country. Locations thus made of points in the reaches adjacent to the marked control points might be accurate enough to serve as control for another similar set of photographs, but it is improbable that locations made from a second or third set of photographs would afford sufficiently reliable control to continue by such an overlapping process the mapping of a deep zone.

Colonel Noirel also speaks of the attractive work which the topographer has in northern Africa where he interests himself in Roman archeology as found in buried cities, in botany, the relation of flora to soil, entomology, geology, etc. His picture is alluring.

Use in Hydrographic Charting

During the last year the Service Géographique has prepared planimetric maps in France at the scale 1: 10,000 from aerial photographs but will add the contours by ground work. Progress has also been made in hydrographic charting by the use of aerial photography in conjunction with a procedure of making locations by sounds. When out of sight of the shore, positions of rocks or other obstructions to navigation have been accurately determined by the time required for the detonation of a bomb exploded under water to travel to three or more shore stations where equipment for registering the disturbance is emplaced. It is stated that the British have located the positions of vessels sunk at the Battle of Jutland as distant as 200 miles from a shore station by this method. When there is only one station on shore available, radio-direction apparatus has been employed in combination with bombs, the intervals of time required for the disturbance to travel by air and by water being used to determine distances. Rocks at depths as great as 40 meters have been photographed in calm clear water.

Experiments in Aerial Surveying in India

Major Lewis and Captain Salmond have given a faithful record in their "Experiments in Aeroplane Photo Surveying" carried out at Agra in India. The object of the experiments was to determine whether plane maps of two different classes, one at a scale of a mile to the inch, the other at a very large scale of a city, could be made by means of aerial photographs as cheaply and as satisfactorily as by the current ground methods.

The report is divided into two parts; the first by Major Lewis, the second by Captain Salmond. Major Lewis is rather emphatic in stating that "It would appear then that there is nothing to be gained by adopting the air method for normal one inch surveys in the plains of India." Captain Salmond concurs with a statement to the same effect. Concerning large-scale city surveys, definite conclusion is not reached as to the value of the method

tried; but the suggestion is made that further experimentation should be carried out.

An estimate, based on the experiment, of the cost of further inch-to-mile surveys by aerial photography gives a rate nearly twice that for surveys made during the three years 1914–1917 by the ground method. The average cost by the ground method is given as 9.1 rupees (about three dollars) per square mile. This is a low cost for plane surveys at the inch-to-mile scale. The explanation seems to be that the amount of data to be obtained for the map is small, the country is easy to travel through, and the native personnel can be employed at modest wages. From the standpoint of economics the test was a severe one for aerial photographic surveying. The conclusion reached may be the final one for work in India, but there was much room for improvement in the instruments used and the manner of carrying out the work.

An area of about five hundred square miles near Agra was selected for the small-scale survey. It consisted of two adjacent fifteen-minute quadrangles in plains country. The air force employed was four airplanes with customary personnel. These were loaned for the experiment with the understanding that they could be kept but a few days and might be recalled at any time. The holding in leash of the air contingent apparently led to an undue hurrying of the photographic work with consequent confusion and an ultimate prolongation of the time required to secure the photographs, and in the end the area had not been completely covered.

The photographic equipment was of an old type such as has for a long time in this country been considered obsolete. It appears that they lacked accessory aircraft instruments to fly courses and to regulate exposure intervals. Captain Salmond, who discusses at some length the aircraft equipment used as compared with that desired, states "that for future work of this kind, *either* machines, instruments, ground control, etc., must be so improved as to eliminate the personal factor in pilots and observers, and so obtain uniform results of a high standard of perfection *or* all pilots and observers employed must have specialized in this class of work, which differs very considerably from active service work." Automatic cameras are now in use, and means have been provided to regulate them; but the getting of useful photographs still depends on a skillful pilot and a trained observer. There seems to be no way to escape the necessity of giving competent men adequate training if success is to be reached in making maps from aerial photographs. In the Information Circular put out by the U. S. Army Air Service considered below, two examples of employing aerial photographs to prepare plane maps at the scale 1:62,500 are given. Each of these maps comprised the area of a fifteen-minute quadrangle. In both instances the work was successful from all standpoints.

A Treatise on Aerial Mapping

In "Mapping from Air Photographs" Colonel Macleod has prepared a valuable treatise. It is evident that he has drawn freely upon the informa-

tion and experience which he gained while in France during the war. Making allowances for new data which have been gathered from experimentation since the date of the publication, the field of the subject has been fairly well covered.

Colonel Macleod gives consideration to many methods or schemes for making use of aerial photographs in mapping rather than confining his endeavor to the presentation of a particular method. Methods of correction for distortion arising from tilt of the camera, such as were employed extensively by the several armies during the World War, receive a chapter of more than twenty pages. This includes an elaborate discussion of the use and mechanism of types of the camera lucida. Part II, which takes up about half of the quarto, consists of "Proofs of Geometrical and Other Theorems Relating to the Plotting and Rectification of Air Photos." Some general principles of perspective figures and special applications of the principles to instruments are given.

In a chapter headed "The Framework" it is made plain that an elaborate net of control points is considered indispensable for accurate mapping with aerial photographs. It is assumed that the control points must be established wholly by ground work. Mapping at what in the United States are considered large scales is in mind. In the United States and in all new countries the great need is for maps at moderate scales (one inch to the mile up to three inches to the mile), and control has to be established as the maps are made. It is therefore of great importance, when considering means and methods of operation, whether the cost of a large number of control points has to be borne or whether it is possible to get along with a fewer number. The feasibility of applying aerial photographs to surveys depends to a large extent on the amount of supplementary ground work required to make them useful. A method of aerial photography cannot be successful for our moderate-scale surveys unless it can be applied with comparatively few points of control which can be readily and inexpensively established.

Photo Restitution

In contrast to Colonel Macleod's compilation, H. Roussilhe has given a study of a particular method of using aerial photographs in connection with accurate mapping. His primary purpose was to discuss the principles of photo restitution[2] as applied to apparatus he devised. As Director of a division (Reconstitution Foncière et Cadastre) of the Ministère des Régions Libérées, he is concerned with restoring properties in the devastated parts of France to their owners, and in order to make the surveys needed to do this expeditiously he turned to aerial photography as a possible aid. The nature of this task required that the results be accurate enough for surveys of the

[2] The word "restitution" has been employed by the French in connection with aerial photographs for ten years or more. It was adopted by the English-speaking forces during the World War and, as used by them, is equivalent to plotting data from aerial photographs. As employed by the French it means the treatment of a photograph through all of the steps necessary to produce a plan or a map of the objects it pictures.

cadastral class. He worked to make his apparatus and method meet that standard. At the date of publication the opportunity had not been afforded him to verify the accuracy of results by a field demonstration, but it is understood that triangulation had been started to make a test survey at the scale 1:2,000.

A large part of the study is given to a discussion of the principles and general conditions of photographic restitution, the characteristics and description of photo-restitution apparatus, and the method of employing the apparatus which was devised by himself. Relationships to be maintained between factors of the aerial camera and those of the restitution apparatus to simplify and facilitate the mapping work are established, and graphs and tables are supplied to provide for ranges in altitudes of flights and inclinations of the camera.

A chapter is devoted to the method to be followed for making surveys with aerial photographs, and, taking 1:2,000 as the scale to be employed, details of the several phases of the work are sketched. The permissible error for positions of triangulation stations is stated as but two-tenths of a meter. Points of the great triangulation net in France of the first order of accuracy are accepted as meeting this requirement, but points of the second and third order do not as a rule meet the requirement and therefore can be used only with caution. At least three points of control are required for each photograph. Levels must also be established with an accuracy commensurate with that desired for the positions of control points. It is considered sufficient to have the elevations of only the control points, for it is expected that all other required vertical data can be obtained from the photographs. It is proposed to take both vertical and oblique photographs in series such that there shall be four photographs covering every part of the terrain. Any point to be located can therefore be intersected by a line from each of at least three photographs. The oblique photographs will be taken with the optical axis of the camera inclined about 30° from the vertical. The elevation chosen for flights is 2,000 meters above the terrain. The cameras being equipped with 50-centimeter lenses, the approximate scale of the photographs will be 1:4,000. It is intended to select enough negatives from the lot thus obtained to make two sets of restitutions, and one set is to be employed to check the results of the other set.

The need for a high order of accuracy in the control scheme is emphasized. This presages a high order of accuracy in making locations of random points and in determining their elevations. Estimates of the refinement possible in the results are given in a chapter headed "Accuracy of Results." Here it is stated that if negatives of the approximate scale of 1:4,000 are used to construct a map of the scale of 1:2,000, the relief of the terrain covered by any negative being not more than plus or minus 40 meters (with reference to control points), errors of location made will not exceed two-tenths of a meter, and errors of elevations determined will not exceed half a meter. Cadastral surveys will require exceedingly careful work, but

topographic mapping at scales commonly used does not require so high a degree of refinement in results. For work at the scale 1: 10,000 it is stated that all except mountainous country could be satisfactorily surveyed by the method.

Major Roussilhe very properly refers to Colonel Laussedat [3] as the father of photogrammetry and gives credit to Captain (later Lieut.-Colonel) Saconney [4] for his studies made of photographs taken with kites before 1913.

Aerial Photography for Cadastral and Geographical Surveys

Since the preceding paragraph was written there has been received a report on the employment of aerial photography for cadastral surveys and for geographic surveys. This report is an amplification of the matter treated in the 1917 annals with several important modifications and additions that are the results of further experience. It is to a certain extent a supplement to the earlier work. The two should be studied together.

The report consists of 116 quarto pages in four parts and is well illustrated with more than fifty figures drawn at liberal scales. The first part is devoted to a description of instruments and the results of a trial survey made to test the method. The second part deals with the procedure of the method, concrete evidence being presented in fair manual form. Details of the method as applicable to mapping at ordinary (1: 5,000 to 1: 20,000) scales are explained in the third part. In the fourth part is seen the influence of the trial survey. Here are mentioned the modifications that are to be made in the aerial camera to be used for cadastral surveys.

The survey was made to compare the aerial method with the ordinary ground method of conducting cadastral surveys. The map was drafted at the scale 1: 1,000, and, in spite of the difficulties encountered, the results are stated to have been more accurate (accidental errors are entirely eliminated) than those obtained by the ground method. The rate of progress was also greater by the aerial method than by the ground method. Elevations could not be determined from the negatives so accurately as by levels run on the ground. The cost of the aerial method did not compare with that by the ground method so favorably as did accuracy of locations and speed. The experience gained by the test led to a significant decision, namely, that aerial photographs intended for survey use ought to be taken by three joined cameras, so arranged that one chamber should point down, one obliquely sidewise, and one obliquely backward or forward. Photographs so taken with multiple cameras can be more readily employed, will give greater accuracy in results, and will cost less to obtain. This is an exceedingly interesting conclusion, for it corroborates conclusions which have been reached in this country after the making of studies and comprehensive tests.

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[3] Aimé Laussedat: Recherches sur les instruments, les méthodes et le dessin topographiques, Gauthier Villars, Paris, Part I, 1901, Part II, 1903.

[4] J. T. Saconney: Métrophotographie, O. Doin et Fils, Paris, 1913.

Work of the U. S. Government Bureaus

The report of the Committee of the Board of Surveys and Maps published as an Information Circular by the Air Service is a résumé of work done by several bureaus of the Federal Government in connection with the use of aerial photography in mapping. The purpose of the report was to determine as clearly as possible how successfully aerial photographs could be used in topographic mapping and in surveys of coasts and what promise lay in future development. The report contains accounts of work done by the Navy, the Army, the U. S. Geological Survey, and the Coast and Geodetic Survey. Several examples of the practical application of aerial photographs are given. Among these are a revision of a coast chart to show changes of a shore line caused by storm action at Tucker Beach, N. J.; a revision of the Santa Monica quadrangle, California, showing great growth of the city of Los Angeles, Santa Monica, and near-by towns, during a period of twenty-five years; the preparation of field sheets of the Schoolcraft quadrangle, Michigan, to which contours are to be added by ordinary methods on the ground; and a plane map, based on land lines, of a quadrangle in Oklahoma which shows cultural development, drainage, and woodland areas. Specimens of mosaics and types of aerial photographs are also shown.

A section of the report is given to a description of aerial mapping cameras and the methods of their use. Problems connected with the application of aerial photography to map-making are treated under the headings: "Pilot's Duties," "Observer's Duties," and "Results of Tests at McCook Field, April-July, 1920."

The cost of making maps from aerial photographs is a difficult question to deal with. This is not the only branch of surveying which suffers from that distinction. All classes of surveys are hampered in many quarters of the globe by unfavorable weather. Weather is of extreme importance in obtaining aerial photographs. On the other hand it is possible with certain types of American aircraft cameras to photograph a thousand square miles in a single fair day with but one camera. Records of weather with regard for aerial photographic possibilities and costs of operating aircraft will undoubtedly after a time become available, so that satisfactory estimates of the cost of all phases of mapping with aerial photographs may be made. This time is to a certain extent anticipated by the report, and numerous items of cost incurred in getting aerial photographs are given.

Part II is a statement showing the possibilities of aerial photography in mapping, with the types of cameras available. Here is reproduced a small map of the United States which shows by shading those parts where relief is too great for aerial photographs to be successfully employed. About four-fifths of the country is represented as susceptible from the technical standpoint of being mapped by the use of aerial photographs.

The average vertical aerial photograph, which is but slightly inclined to the horizontal plane, may be used to measure angles from its center,

because lines drawn from the center to objects pictured represent fairly accurately the true bearings to the objects. So used the photograph is exactly the equivalent of a map which is mounted on a slightly tilted plane-table. By means of the three-point or of the tracing-paper method a fair location can be made of the point occupied with the plane-table, even though the plane-table be only approximately level. Having made the location of the station, the map can be satisfactorily oriented and any object in view can be sighted. The same sort of tracing-paper solution can be made to determine the position of the center of vertical aerial photographs, with reference to three or more known points that it embraces, by placing over the photograph a tracing of the known points and shifting it about until the points fall on their respective radial lines. When this is done, the tracing is properly oriented with respect to the photograph, and bearings to any object pictured can be traced. The centers of the photographs always correspond to the positions to be occupied.

This is the key to the use of vertical aerial photographs for mapping. It affords a means of extending surveys over considerable distances providing there is a base to start from and a point at the end to tie to. It is not uncommon, in reconnaissance and exploratory surveys, to extend maps by the plane-table intersection method for a hundred miles or more from a single comparatively short base. Extensions of maps by aerial photographs have been successfully made over distances as great as twenty miles; and, though the proof that similar extensions can be made over distances as great as a hundred miles is lacking, the evidence available indicates that there is only one thing that can hinder its being satisfactorily done, and that is excessive relief. For reconnaissance surveys the amount of relief which can be successfully coped with is roughly about 1,000 feet between two overlapping photographs, and this corresponds to about 1,000 feet in any mile of the course. A continuous rising and falling of the ground, if the slope be not greater than 1 in 5, would be no more difficult to map by aerial photography than the average rolling country.

The problem of determining elevations from aerial photographs to suffice for placing contours on maps is a complex one. With instruments and facilities now available the solution necessarily involves, and must be preceded by, the accurate location of points of control. To be practicable in moderate-scale surveys of large areas, this means that the necessary points of control must come in large part from the photographs themselves. This task is receiving the attention of mapping agencies of the Federal Government.

THE POPULATION PROBLEM

By Raymond Pearl
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In the opening chapters of the first edition of his "Essay on the Principle of Population," T. R. Malthus said: "I think I may fairly make two postulata. First, That food is necessary to the existence of man. Secondly, That the passion between the sexes is necessary, and will remain nearly in its present state, . . . Assuming, then, my postulata as granted, I say, that the power of population is indefinitely greater than the power of the earth to produce subsistence for man." In the century and a quarter since these words were published the evidence not only of their truth but also of their profound wisdom has multiplied manyfold. Malthus could know as facts of experience, when he wrote in 1798, only what was behind him. What was to happen in the nineteenth century he could only conjecture.

Proceeding from the earliest to one of the most recent scientific studies of the problem of world population, it is to be noted that Griffith Taylor, in his original and thoughtful paper on "The Distribution of Future White Settlement" in the July, 1922, number of the *Geographical Review* envisages clearly the coming limitation of the earth's population, by reason of its saturation in respect of means of subsistence. The time factor in this population saturation, is one about which there may be difference of opinion. But it really matters little whether one takes Knibbs's estimate of 450 years quoted by Taylor, p. 402, or that author's own suggested figure of about two centuries or the perhaps even shorter estimate to which my own mathematical studies have tentatively led me. The important consideration is that population, so far as we know, always has grown and certainly is now growing at a rate which, if continued, will some time completely populate the habitable portions of the earth with a density which will be the maximum consistent with the continued existence of human beings.

Explanation of Figure 1

Figure 1 of this article gives a picture of some aspects, at least, of what has happened since the beginning of the nineteenth century. It will pay us to examine it with some care, because it presents the problem that worried Malthus, as it exists here and now. It will appear with startling emphasis, that nothing which has happened since 1798 has in the least degree mitigated or softened or altered in any true sense the relentless insistence of Malthus's logic. On the contrary, the developments of the last century have made it far plainer even than it was to so clear-visioned a major prophet as he was, that the population of the world cannot go on increasing at

anything like the rate of growth that has prevailed in the past more than a short time longer.

This diagram is constructed from official figures, conveniently compiled in the annual volumes of the "Statistical Abstract of the United States." It is made according to the following plan. The absolute values for population and for the several other items of production, trade, and the like, included in the diagram, were taken as of value 100 in the year 1800, and then at each subsequent point on the diagram the absolute figures are reduced to relative values on the basis of the 1800 figure taken as 100. The only exception to this procedure is in the case of railways and telegraphs, which had not come into existence in a statistically significant sense in 1800. In those cases, the figures of their first appearance in the statistics (1830 in the case of railways, and 1850 in the case of telegraphs) are taken as 100, and the subsequent values are referred to the initial value as a base. The relative figures so obtained were then plotted on a logarithmic scale. The virtues of such a scale of plotting are, in the present case, twofold. In the first place, it enables us to include in one diagram of moderate dimensions the enormous range of variation exhibited by certain of the items. In the second place, it is a property of logarithmic charts that the *slopes* or trends of all lines are directly and visually comparable one with another. This is not true of charts plotted on an arithmetic scale, unless the absolute values plotted chance to be of approximately the same magnitude. The figures on the left hand margin of the diagram are to be interpreted in this way. If any relative value rises to the line marked 1,000, it means that the item exhibiting this figure has increased tenfold. If it rises to the line 10,000, it means that the item has increased, in the period covered, a hundredfold; if to the 100,000 line, it has increased a thousandfold.

The original data upon which the diagram is based, together with the calculated relative values, are presented in Table I. It is to be noted, as a matter of course, that the figures of Table I cannot possibly be meticulously accurate. They represent, in some of the items, only rough statistical estimates. But they cannot possibly be so far in error as to affect sensibly the general lesson which the diagram teaches.

The World's Relative Progress in Population and Production

With these explanations of the construction of the diagram, we may proceed to see what it means. In the first place it appears that the world's population has increased in the century a little less than two and a half times. This is, in itself, not an extraordinary figure and would appear to be nothing to be in any way alarmed about. It is far smaller than the rate of population increase under special circumstances, where the population of a particularly favored area may double itself in fifteen to twenty years.

The point of real interest in the diagram, the thing which gave purpose to the writing of this article, is that *the slope of every other line on the chart is*

TABLE I—WORLD'S DEVELOPMENT OF POPULATION, PRODUCTION, VESSEL, TONNAGE, AND COMMERCE: 1800 TO 1918

YEAR	POPULATION		COMMERCE TOTAL		TONNAGE SAIL AND STEAM		RAILWAYS		TELEGRAPHS		PRODUCTION OF					
											COTTON		COAL		PIG IRON	
	ABSOLUTE MILLIONS	RELATIVE	ABSOLUTE MILLIONS	RELATIVE	ABSOLUTE	RELATIVE	ABSOLUTE THOUSAND MILES	RELATIVE	ABSOLUTE THOUSAND MILES	RELATIVE	ABSOLUTE MILLION POUNDS	RELATIVE	ABSOLUTE MILLION SHORT TONS	RELATIVE	ABSOLUTE MILLION TONS	RELATIVE
1800	640	100	1,479	100	4,026	100	——	——	——	——	520	100	11.6	100	0.8	100
1820	780	122	1,659	112	5,834	145	——	——	——	——	630	121	17.2	148	1.0	125
1830	847	132	1,981	134	7,211	179	0.2	100	——	——	820	158	25.1	216	1.8	225
1840	950	148	2,789	189	9,380	233	5.4	2,700	——	——	1,310	252	44.8	386	2.7	337
1850	1,075	168	4,049	274	12,334	306	24.0	12,000	5	100	1,435	276	81.4	702	4.7	587
1860	1,205	188	7,246	490	16,600	412	67.4	33,700	100	2,000	2,551	491	142.3	1,227	7.2	900
1870	1,310	205	10,663	721	15,940	396	139.9	69,950	281	5,620	2,775	534	213.4	1,840	11.9	1,487
1880	1,439	225	14,761	998	20,280	504	224.9	112,450	440	8,800	3,601	693	340.0	2,931	18.0	2,250
1890	1,488	233	17,519	1,185	17,461	434	390.0	195,000	768	15,360	5,600	1,077	466.0	4,017	27.2	3,400
1900	1,543	241	20,105	1,359	20,531	510	500.0	250,000	1,180	23,600	6,247	1,201	800.0	6,897	40.4	5,050
1906	1,579	247	27,148	1,854	25,522	634	564.0	282,000	1,200	24,000	7,650	1,471	885.0	7,629	58.7	7,337
1910	1,616	253	33,634	2,274	26,670	662	637.0	318,500	1,307	26,140	9,013	1,733	1,141.6	9,841	65.8	8,225
1911	1,630	255	35,979	2,428	28,298	703	666.0	333,000	1,356	27,120	10,634	2,045	1,309.6	11,290	62.4	7,800
1912	1,643	257	39,570	2,675	29,061	722	683.4	341,700	1,400	28,000	10,301	1,981	1,377.0	11,871	72.8	9,100
1913	1,652	258	40,420	2,733	30,408	755	690.2	345,100	1,462	29,240	10,809	2,079	1,478.0	12,741	77.9	9,737
1914	1,661	260	37,760	2,553	31,674	787	703.5	351,750	1,489	29,780	11,933	2,295	1,346.0	11,603	56.8	7,100
1915	1,672	261	31,302	2,116	31,693	787	717.5	358,750	1,526	30,520	8,805	1,693	1,169.6	10,083	59.0	7,375
1916	1,692	264	46,523	3,146	31,293	777	720.3	360,150	1,564	31,280	9,047	1,740	1,242.9	10,715	71.4	8,925
1917	1,693	265	52,781	3,569	29,805	740	729.8	364,900	1,568	31,360	8,705	1,674	1,317.9	11,361	64.6	8,075
1918	1,699	265	62,802	4,246	31,139	773	732.8	366,400	1,586	31,720	8,845	1,701	——	——	62.0	7,750

far steeper than that of the population line. Thus it appears that, while the population was increasing two and a half times, the world's coal production and pig iron production increased from fifty to seventy times and by 1917 had increased nearly 100 fold over the conditions of 1800. The world's cotton production increased in the same period twentyfold; the world's

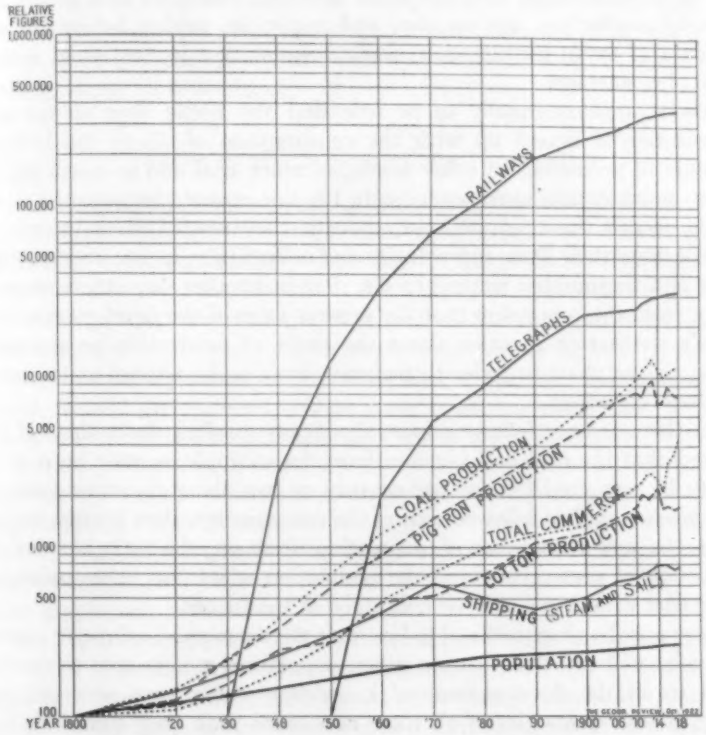

FIG. 1—Diagram showing the progress of the world's population and production of certain materials in the nineteenth century.

commerce, a little more than that; the world's shipping increased something like eightfold, while the railway mileage increased, in the period from 1830 to 1917, by roughly 3,000 fold, and the telegraphs 300 fold.

In the face of such figures as these, one may well ask, "Where are we going?" No sensible person will, for a moment, suppose that such lines of this diagram as those for cotton production, coal production, or pig iron production can go on indefinitely increasing at the rate shown in the 117 years covered. It would be manifestly absurd. Yet, on the other hand, it must be remembered that these figures are world figures, approximate if one pleases, but on the whole certainly not far from the true, unknown, facts. This consideration means that the population of the world, in one

way or another, has used up in the business of carrying on its life all of the coal, all of the pig iron, and all of the cotton for which the production trends are indicated on the diagram. There is no such thing as "interworld" trade. Therefore it cannot be asserted that a part of this production went for export and consequently need not be worried about. Trade relations have still to be established with the other planets. When we look at the facts of *world* production, we are also, and implicitly, setting before ourselves the data of *world* consumption, using consumption in the broad sense of usage plus wastage.

Now it appears equally to be true that the whole fiber of our social organization is bound up with the consumption of about the indicated amounts of products. In other words, so much coal and so much pig iron and so much cotton were produced in the last century because the world's people needed them, or, at least, thought they needed them to maintain and continue their lives, individually and collectively, in the way they were doing and presumably wanted to do. Put in another way, there seems no escape from the conclusion that the present stage of the development of the world's civilization requires about the ratios of production to population shown on the chart in order to maintain itself and continue at its present standards of living.

But there at once follows a most significant corollary from this. If it be granted that the coal and pig iron lines, for example, cannot by any possibility be projected for another century or two along the same lines that their production has followed during the past century, then it must be that, unless the rate of increase of population slows up, the ratio between the production of these goods and the population which has been maintained in the past cannot possibly be continued in the future.

There may be those inclined to interpret the diagram in a directly opposite way; who will say that, since a given population is now able to produce, owing to all the developments of knowledge which have occurred, such vastly greater quantities of all these necessities than they were able to in 1800, there appears no reason why the process should not go on at the same rate in the next century that it has in the one just past, it being presumed that mankind will increase in the organized intelligence and awareness which constitutes applied science. This view overlooks the fact that besides the human element involved in production, there is another of even greater importance which finally limits the process. It is, that the volume and the surface of the planet on which we live are strictly fixed quantities. This fact sets a limit, if no other does, to the indefinite projection of these straight lines of production trend which make angles of 30 to 45 degrees with the horizontal. For example, one would not have to project the coal production line, along the course it has followed during the nineteenth century, over many years before it would reach a point where it would indicate a produced tonnage such that the entire globe would have to be solid coal to permit of its realization. Eventually there must come a turn in these

production lines. One suspects that it may have already come in the case of pig iron and cotton.

The curves for railways and telegraphs are interesting in this connection. On the whole, the world has finished the major portion of its railway building. There will, of course, be many more miles of railway built as time goes on; but the additions will clearly be at a much slower rate than has been the case from 1830 up to the present time. In other words, the world is nearing a stage of saturation in respect of railways. It has, roughly speaking, about all it needs.

Trends of the World's Food Production

So far nothing has been said about food, the most important single item in human subsistence. We come here upon much less secure ground, statistically speaking, because there are no particularly accurate world figures for even the most important of crops. The data that are available are distinctly rough estimates, except in the case of sugar, where, owing to the nature of the manufacturing processes involved, the total production is rather accurately known. For the other crops the estimates are, in general, simply the summed returns from countries which have a system of agricultural statistics. Probably this leaves out a significant proportion of the total production. But there is every reason to believe that the *trends* shown by the figures which are available are substantially in accord with what would be shown if accurate total figures were at hand. Inasmuch as it is only the general trend of the figures that we are interested in for the present purposes, the data set forth in Table II will suffice. The data are shown graphically in Figure 2.

From Figure 2 it appears that a process is going on in world food production which is precisely the same in kind, though different in degree, as is shown in Figure 1 for the production of other things than food. Until 1916 the food production curves were rising *at a more rapid rate* than the population curve. In the last three years of the chart the upsetting conditions of the war, combined with unfavorable seasons in many regions, caused an abrupt fall in the world's food production. But, leaving these years out of account, it is plain that the world's food consumption (for here as before production means consumption, in the broad sense, when we take the world as a whole) has increased faster in the last 20 years than has population. This is particularly marked in the case of the commodity sugar, which in some degree may be regarded as a food luxury.

It will be understood, of course, that not the whole of any one of the crops shown in Figure 1, is *directly* consumed as human food. In some cases, notably corn, the fraction that is thus directly consumed by human beings is relatively small. But indirectly and in converted form, through animals and manufactured products, the bulk of all edible farm crops contributes in greater or less degree to human nutrition. We eat the corn in the form

of pork, we drink (or did drink) a good deal of barley as beer, we eat some of the oats as oatmeal, some as eggs, some as milk, and so on.

Now, a superficial view of the situation revealed in Figures 1 and 2 is likely to be extremely complacent. Population has grown since Malthus's day. Yes, about as he said it would. But Malthus quite overlooked the powers of man himself to make nature do his will. As the population has increased man has made the means of subsistence increase still faster. So far from population catching up with the means of subsistence, it is plainly out-distanced in the race. So will the unthinking interpret our charts.

TABLE II—WORLD PRODUCTION OF PRINCIPAL FOOD CROPS

YEAR	CORN	WHEAT	OATS	BARLEY	RYE	POTATOES	SUGAR
	MILLION BUSHELS	MILLION BUSHELS	MILLION BUSHELS	MILLION BUSHELS	MILLION BUSHELS	MILLION BUSHELS	MILLION POUNDS
1895	2,835	2,593	3,008	916	1,468	——	17,779
1900	2,793	2,641	3,166	960	1,558	4,382	19,370
1905	3,461	3,327	3,510	1,180	1,496	5,255	21,310
1910	4,032	3,575	4,182	1,389	1,673	5,275	33,415
1911	3,461	3,541	3,786	1,375	1,579	4,749	38,083
1912	4,055	3,760	4,585	1,457	1,901	5,873	35,585
1913	3,587	4,127	4,697	1,650	1,880	5,803	40,788
1914	3,878	3,486	4,035	1,463	1,597	——	41,972
1915	4,213	4,173	4,389	1,560	1,586	3,044	41,512
1916	3,101	2,279	3,941	1,437	530	1,720	37,069
1917	3,483	2,224	2,975	914	434	2,734	37,729
1918	3,038	2,818	3,052	1,077	529	——	38,375

But we are unable to convince ourselves that such complacency has any warrant. We believe that anyone who will take the trouble to read even the present article carefully and will ponder over the *facts* it presents, rejecting if he likes everything that savors of opinion or theory, will be bound to feel some misgivings about the world's ability to go on indefinitely increasing both its population and its average standard of consumption or of living. For precisely that is what we are now doing. The steeper slopes of the production with the population line can only mean (recalling always that we are dealing with the world figures) that the ratio of consumption to population has been steadily widening. But a widened consumption ratio represents a more extravagant standard of living. It can, broadly speaking, mean nothing else. If people, taken at random, consume (use and waste) more goods now than people did say 20 years ago, then plainly their standard of consumption has gone up.

RESULTS OF OTHER STUDIES

Space will not permit any exhaustive review of the literature, but the author of the present article desires to quote briefly from two recent writers

on the general subject of population, in order to show that he does not stand alone in the views suggested. One of the most careful and thorough of recent students of the problem is Thompson. In rounding up the results of his study he says:

> Another conclusion which seems to me to be warranted is that population cannot continue to increase at its present rate without being more and more subjected to the actual want of food, provided the distribution of labor between agriculture and the non-agricultural industries continues in its present trend (the trend found in the more highly developed countries). Nor can a greater and greater proportion of the population be devoted to agriculture and the present rate of increase continue without checking a progressive standard of living. The non-agricultural industries are not yielding increasing returns in such ratio that they can furnish the necessary material means for a progressive standard to such a rapidly increasing population. Thus whatever the direction of development, a progressive standard of life and a population increasing from 1.5 per cent to 2.0 per cent a year cannot go on together for long, in a large part of the world. Therefore, either our present standard of living must be simplified as an increasing proportion of the population becomes rural or the present rate of increase of population must be lowered. Probably both must take place in order to have a really progressive civilization.
>
> To simplify our present standards of living does not necessarily mean a lowering of them. It means rather that a good many of the things of our civilization which we consider essential today may be found to be merely passing phases, induced by our rapid industrial development. We have become accustomed to think of civilization and culture and progress as of necessity involving all the complexities of our present existence. It is open to question, however, whether much of our present complexity is not a hindrance to real culture rather than an aid. There cannot be much doubt that as people are becoming more educated they are becoming more self-contained, and they begin to see that the way to get the most out of life is to put the most into it, and not to surround themselves with all the luxuries and baubles they can afford.
>
> But it is doubtful whether even such a simplification of life of the people of the more highly civilized nations will enable them to support in comparative comfort an ever-increasing proportion of their populations, or even the same proportion as at present, if it is not accompanied by a lower rate of natural increase of population. A slower rate of increase of population will give more time to adjust standards of life to surrounding conditions and to direct the course of progress; without it most of our efforts must be directed towards the more pressing of the problems of our present-day life. A greater and

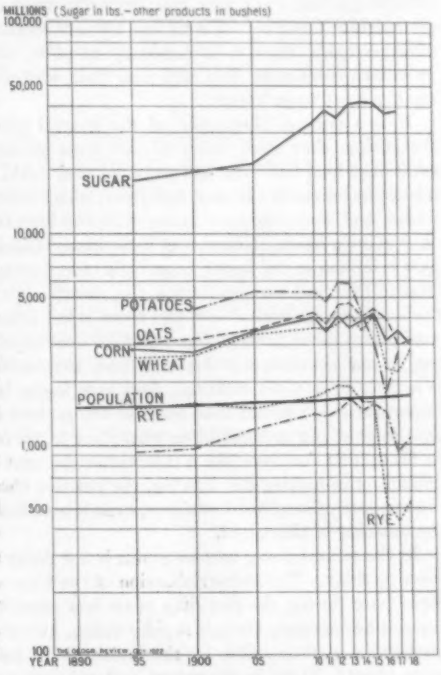

FIG. 2—Diagram showing progress in world food production in relation to population.

greater control over the growth of population is essential to a growth of rational social control.[1]

Another leading student of the problem, East, has this to say in a recent paper:

Let us think in terms of land. A careful study of the available statistics shows that, by and large, it takes about 2.5 acres to support each individual. Some self-supporting nations can make out with less, but only when they put all their efforts into cultivating their richest land; others with less efficient methods take much more. Taking this as the average figure, then, it is necessary to plow, plant, cultivate, or otherwise tend, some 37 million acres more land each year than was ever so treated before, if the nations of the earth are not to go hungry.

It is a curious illustration of the general tendency of people to be optimistic about everything, that even many of our most eminent economists believe this wresting of additional food from the soil to be an easy task. They draw wonderful pictures of what science has done in the past few years, make roseate prophecies of similar advances in the future, and keep everyone happy with the idea that the human race has unlimited credit on Nature's bank. Never was logic more fallacious. The total land area of the globe, 33,000 million acres, seems large, it is true, but one cannot utilize all this area for raising crops. Take out the mountains, the deserts, the undrainable swamps, in short the areas not available for agriculture, and there is left about 13,000 million acres. Of this potential world farm some 5,000 million acres are now being cared for by the hand of man. According to our previous calculations, then, the maximum population the earth can support is a little over 5,000 millions. And here is the heart of the matter—the time when this important event would take place at the present rate of increase is not so far distant but that some of our grandchildren would live to see it. Mind, I do not say the world is going to fill up and run over like a tub within the next century or so. Of course it is not. The difficulties of digging out a living, the positive checks to population, will see to it that the present rate of increase diminishes, even if no other checks intervene. I am merely showing the meaning of this speed.

In the second place, human genius is not doing for agriculture just what our economists seem to think. The industrialization of the Caucasian world which has gone on at such a rapid pace during the last fifty years has provided for more people, it is true. In fact, population increase, though rapidly rising, has not really caught up with the increase in production made possible by the multitude of mechanical inventions. But why has this come about? There is one reason and only one reason for the situation. We have had a reserve of new land to draw upon. Mechanical invention simply made it possible for a given unit of man power to cultivate more land and to distribute its products more rapidly and equitably. With the exception of the credit to be given the mechanical production of chemical fertilizers, thus far negligible in a world-sense, the Age of Steel has not aided agriculture one iota, when computation is made on unit area. In other words, the provisions John Doe raises on his hundred-acre farm have not been increased because of traction plows and steam threshers. But John Doe has had cheap land available and has been able to cultivate more of it than he could by the old hand methods. Yields per acre were actually decreased. What will happen when the new land gives out? It is giving out, giving out rapidly. Well, the result will simply be this: the machine farmer will give way to the hand farmer. The American who now cultivates 26 acres per capita will have to put more man power into his efforts and will approach the Belgian standard of 5 acres per capita. He will get greater yields on a given acre by so doing, even as the Belgian farmer gets greater yields, but the yield per capita will sink slowly downward. So few people seem to appreciate this difference of standard. They look at the English yields of wheat and

[1] W. S. Thompson: Population: A Study in Malthusianism (Columbia Univ. Studies in Hist., Econ. and Public Law, Vol. 73, No. 3), New York, 1915, pp. 163-165.

German yields of potatoes and wonder why the yields per acre in the United States are so low. They are low simply because the United States has had new lands to exploit. The country has been in an era of "increasing returns;" when shallow plowing, incomplete cultivation, and other cheap extensive methods would still yield a fair profit. European agriculture, on the other hand, has long been experiencing the pain of "decreasing returns." Year by year they have been faced with the necessity of getting more and more out of their land, to pay the mounting rentals. They have succeeded remarkably well; but they have only had this success because they have put more toil, more man power into their work. We are now entering on this era of diminishing returns per person in this country. Our yields per acre are rising and will continue to rise. But they will rise because of the increased effort put into the work rather than because of new methods of tilling and of time-saving devices.[2]

These quotations from two of the leading investigators of the problem of population at the present time will be sufficient, it is thought, to indicate that the author is not alone in supposing that this is a real problem, perhaps the most significant one facing mankind today.

It is not my purpose in the present article to do any more than present the general problem. With my colleague, Dr. Lowell J. Reed, I have in preparation a book on the subject, in which the detailed facts as to population growth in various countries will be presented, together with a mathematical theory of population growth, which may be of value in approaching the solution of the world-wide and pressing problem.

[2] E. M. East: Future Food Prospects, *World Agriculture*, Vol. 2, 1921, pp. 130–132.

ON THE FUTURE DISTRIBUTION OF WHITE SETTLEMENT

By WALTER F. WILLCOX
Cornell University

At the request of the Editor of the *Geographical Review* I send these brief comments on Professor Taylor's thoughtful and thought-provoking article, "The Distribution of Future White Settlement," in the July number. The main issue between Professor Taylor and me probably lies in our differing answers to his fundamental question, which is this: Assuming that accidental and artificial influences upon the distribution and density of the white population of the earth are destined to become in future less potent, and this I concede only for the purpose of raising the main issue, will physiographic influences, such as temperature, rainfall, altitude, and coal supply, become dominant and in combination fix the future distribution and density of the earth's white population? This question Professor Taylor answers in the affirmative. My answer would be, We cannot tell.

The view which seems to me defensible as an alternative to his, even in face of his evidence, is that, if the artificial influences become less potent, human and social influences, conscious and unconscious, are likely to compete with physiographic influences in filling the void.

Temperature escapes human control, but wheat does not. There is a hybrid variety of wheat, Marquis, which was first bred less than twenty years ago and which ripens earlier than competing varieties. In 1918 this variety yielded in Canada alone a crop of 129 million bushels and had pushed the area for the profitable growing of wheat farther into the Canadian Northwest. In my opinion there is doubt whether the whites will continue to be tied as closely as now to wheat for their main food and more doubt whether wheat will remain limited to its past and present range.

With scientific agriculture and especially its practical applications still in their infancy, I cannot foresee what developments will come from them nor how far man with the help of this potent agent can modify the production of food in various areas. If in the last half century or more the centers of agricultural production in Australia had shifted as far as they have in the United States, perhaps Professor Taylor would be less ready to assume a static agriculture through the next few centuries.

At another point I dissent even more confidently. He says "Health is controlled primarily by temperature and humidity." In my opinion it is not controlled by any one or two influences but is affected by individual, family, and social action more than it is by natural conditions. The motto of the New York State Department of Health: "Public health is purchasable; within limits a community can have the death rate it is willing to pay for" seems to me nearer the truth and more likely to be serviceable to mankind than the somewhat fatalistic dogma, "Health is controlled primarily by temperature and humidity."

Professor Taylor says: "The world as a whole has doubled its population during the last ninety years." The statement made with the presentation of no evidence and the mention of no authority illustrates the author's fondness for sweeping generalizations inadequately supported. My own recent study of the growth of the world's population led me to conclude that since the middle of the eighteenth century it has been rapidly increasing and is now perhaps two thirds larger than then. I doubt that during the last ninety years its increase has been greater than 50 per cent.

In the same connection Professor Taylor discussed briefly the growth of American population where the facts are well established. He wrote:

"The population of the United States has been doubling itself approximately each thirty years during the last century. It was 25 millions in 1850, 50 millions in 1880, and 100 millions in 1910. If this rate of increase continue, it will have grown to the 700 millions mentioned in Table VII in less than one hundred years."

The figures and increases are as follows.

POPULATION OF THE UNITED STATES IN MILLIONS

Year	Same Area	With Territorial Accessions	Increase in 30 Years	
			Amount	Percentage
1850	23.19	23.19		
1880	50.16	50.16	26.97	116
1910	91.97	101.15	41.81	83

To round 23.2 millions to 25 millions is a questionable procedure but less so than to raise a figure of less than 92 millions to 100 millions or to count the population of the Philippine Islands (7⅔ millions in 1903) as a part of the increase in the population of the United States between 1880 and 1910. The figures in the last column of the table show how wide of the truth is the statement that the population of the United States has been doubling every thirty years. Few facts about our population are better established or of greater importance than its slackening rate of growth since 1860.

May I put on record here my sceptical attitude towards any and all efforts to determine the population of the earth or any large part of it for more than a few years ahead, whether the method employed be one of subtle mathematical analysis, or merely the assumption that conditions and changes of the recent past will continue for some time? To my mind the largest population fact of the present day is the decreasing birth rate, due in the main to volitional control. It is because of this new phenomenon, I believe, that we stand at the threshold of a new era in the history of population. I doubt that we can gain much by striving to foresee how population will grow through coming generations or how it will be distributed in the remote future after this new agency has worked out its results and man has become thereby more and not less the master of his fate.

GEOGRAPHICAL RECORD

AMERICAN GEOGRAPHICAL SOCIETY

Presentation of the Charles P. Daly Medal to Sir Francis Younghusband. Announcement of the award of the Charles P. Daly Medal of the American Geographical Society to Lieutenant-Colonel Sir Francis Younghusband, President of the Royal Geographical Society, was made in the July number of the *Geographical Review*. The presentation of the medal took place on July 19 at the American Embassy in London.

In presenting the medal the Ambassador referred briefly to the circumstances under which the award was established, to the accomplishments for which it was bestowed, and to the previous holders, making felicitous reference to the merits of the present recipient. In response, Colonel Sir Francis Younghusband expressed his appreciation of the medal, which he likened to the embodiment in gold of the friendly spirit which he met with in his visit to the United States in 1914. The Earl of Winterton, who had been designated by the Secretary of State for India to represent him, then proposed a vote of thanks to the Ambassador, which was seconded by Sir Maurice de Bunsen on behalf of the Council of the Royal Geographical Society.

EUROPE

The Geographical Factor in Spanish Civilization. In a scholarly volume full of new points of view Emilio H. del Villar seeks an explanation of the lowly estate of Spain among the civilized nations of today ("El valor geográfico de España: Ensayo de ecética. Estudio comparativo de las condiciones naturales del país para el desarrollo de la vida humana y la civilización," Madrid, 1921). Del Villar is not satisfied that it is due to her religion or bad government. When Spain was the greatest country in Europe she was just as catholic and just as monarchial as she is today, and then she easily outclassed the northern nations that now excel her. He thinks it absurd to say the Spaniard is not a worker. He emphasizes the part played by the environment which he calls the "geographic factor."

He devotes half his book to examining this geographic factor at work in the United States—an unusually favorable country for its study; in Europe—the region of fullest knowledge and home of many interesting nations; and in South America—a region of recent development. The other half applies the method of study so formed to Spain.

The eastern central region of the United States has the great population densities and the great city groups, rising to maximum intensity in the belt between Washington and Boston. Agricultural production is high there, but by no means coincident with the densest population. Mining, important as almost nowhere else in the world in many parts of the United States, promotes neither density of population nor the growth of cities. Much of it is carried on in the sparsely settled regions of the West. Iron is enormously abundant, but the ores occur quite apart from the centers of population. The coal beds, also magnificent, are nearer the great centers, but none are within the dense eastern belt. But the manufacture of iron from its ore is carried on near the coal, especially in the dense eastern coast belt.

This amounts to a law or principle. In lands of summer rain and abundant crops the places where minerals are refined and manufactured are the places where the most varied manufactures will be carried on, especially if there is good access to the ocean, the pathway of commerce. Here it is that great population masses and great cities are bound to arise. In Del Villar's phrase this gives high *ecetic* value, conduces to a high degree of habitability.

In Europe are found the same conditions. The great city and population masses there constitute a sub-Nordic zone consisting of the Scotch Lowlands, England, the north of France, Belgium, Holland, western and central Germany, and—in a decreasing degree—Denmark; a summer-rain region like eastern North America, producing abundantly without irrigation, a hay-and-fodder country with many cattle and large cereal and vegetable crops. This zone has much coal and iron also, which it works up on the coal or near by at convenient seaports, developing manufactures of vast importance with raw materials brought from far and near.

Spain has a thinner population and few cities. It lies in an outer, Mediterranean zone. Only the north has summer rain and abundant, moisture-loving growths. The rest of Spain is dry, a land of winter rain and woody thickets, needing the help of irrigation to become productive. Moreover, this scrubland has a very thin soil and has been widely "desertized" both by the removal of the scrub and the exhausting of the thin layer of humus by wheat growing. This condition, widespread in Mediterranean regions, is accompanied and aggravated by destructive hillside erosion which annually invades greater and greater expanses. Del Villar proposes as a remedy less wheat, more fodder, more cattle, more manure—to be applied in connection with chemical fertilizers—to restore the humus. Regions that invite tree crops—almonds, chestnuts, walnuts, and olives—have grown too much wheat, which Spain should have learned long since to seek in the better wheat lands of America.

Obviously it is a difficult thing to change a nation's crops, yet Del Villar must know that the Danes were obliged by American competition to make the same shift from grain to cattle raising and made it successfully. An interesting step in that change of Danish agriculture was the founding of agricultural high schools to enable the people to learn the new business. In this respect the geographical factor was crowding both Spain and Denmark, and the difference in the present prosperity of the two countries seems due to the energetic reaction of the Danes to this crowding and the very slight reaction of the Spaniards. Del Villar is right in drawing attention to the geographic factor, but he seems to minimize the human one. The Spaniard is the most important item in the Spanish environment. Take the case of the olive tree, one of nature's kindest gifts to Spain. According to Theobald Fischer ("Der Ölbaum," Gotha, 1904) the Spanish crop of oil in 1890 was 3,070,000 hectoliters, the Italian 1,300,000, the French 300,000. But the price paid for a hectoliter of Spanish oil was $13; for the Italian, $30; and for the French, $32. "It corresponds to the state of Spanish agriculture and general culture that Spain produces the finest trees and excellent olives but very low-grade olive oil." "The treatment of the tree and fruit and the method of extracting the oil [in Spain] are for the most part so primitive that of late enterprising Frenchmen and Italians go to Andalusia in Spain and have the olives picked and pressed under their own supervision to get really good oil." If the Spaniards could have got the French price for their crop of 3,000,000 hectoliters, they would have added $57,000,000 to its value, more than twice as much as Spain's total expense for education in 1920.

The government does not gather correct statistics, does not accurately inform itself of the facts. It does not help its people adjust themselves to a new condition and leaves 59 per cent of them today illiterate.

Besides not having rain enough for a dense population Spain lacks coal. She has very valuable mineral deposits, especially iron ores, but little coal, producing 4,000,000 tons in 1913 and importing 3,000,000 to make up its consumption of 7,000,000. That is very little indeed compared with the United States or Germany or England. Spanish water power may be equivalent to 20,000,000 tons of coal—estimates differ enormously. The study of the United States and Europe suggests that the mere presence of minerals will not create large population centers. It is the reduction and manufacture of iron and other minerals together with the allied manufacturing that have so much ecetic importance. But Spain is deprived of the favorable effects of the possession of ores by what Del Villar calls the *restrictive action of the optimum*. An optimum is a country of high ecetic value. In Spain's case the optimum is England. It restricted the activities of Spain by purchasing Spanish iron ores and taking them away to smelt and manufacture with the abundant English coal. English capital conducts even the mining operations in Spain, increasing the density of population and making cities grow in England instead of in Spain. In the same way England is enabled to draw from all parts of the British Empire and from other countries as well. We are invited to see the ground of Spain's inferiority in Spain's defective geographic factors.

But if our sense of the Spanish environment as a trying one is heightened we yet are not shown the Spaniard making a very adequate effort to dominate it.

MARK JEFFERSON

Group Cities of Great Britain. The 1921 census of Great Britain shows not only a population of city dwellers but of dwellers in large cities. Over 50 per cent of the population lives in cities or group cities of over 100,000 (the approximate percentage in the United States

is 26); over 35 per cent in the great urban aggregates of over 1,000,000. This phase of population distribution is discussed by Mr. C. B. Fawcett in an article "British Conurbations in 1921" in the May number of the (British) *Sociological Review*. The phenomenon of conurbations, or group cities, is of recent origin, an outgrowth of modern industrial life. Conurbations usually arise by the simultaneous expansion of a number of neighboring towns which coalesce into one continuous urban area. A peculiar opportunity for such development in Great Britain is afforded by the unique concentration of population on the coal fields (compare Mark Jefferson: The Distribution of British Cities, and the Empire, *Geogr. Rev.*, Vol. 4, 1917, pp. 387–394). Five of the seven British conurbations of the first magnitude are on the coal fields. The population of these and the smaller group cities has been computed from the census figures for districts officially classed as urban. It is not exact but the best that can be done with available statistics. Continuity of urban occupation is the criterion in determination of the area of the conurbation; but, as Professor Jefferson has pointed out in discussing the same phenomenon in the United States ("Great Cities of the United States, 1920," *Geogr. Rev.*, Vol. 11, 1921, pp. 437–441), difficulties arise in particular cases, and there local knowledge is necessary.

The population of the London conurbation is given as that of the Greater London of the census (the City and the Metropolitan Police Districts). It numbers 7,476,168. Professor Jefferson gives 6,657,447 for the New York group city. The Liverpool conurbation is the urban area occupied by workers of the Port of Liverpool and those dependent on them and subsidiary industries of the port. Its 1,194,780 people are concentrated about the harbor of the Mersey mouth in an unusually compact manner. Manchester, the largest of the coal-field conurbations, occupies the upper basin of the Mersey and numbers 2,351,156, including an inner city, Manchester and Salford, with somewhat less than half the population, and an outer ring. The Birmingham group is comprised by the Black Country: it focusses on this city which numbers about half the group population of 1,707,442. Glasgow includes the greater part of the population of 1,243,746 constituting the conurbation of the lower Clyde valley. The Tyneside conurbation, with 845,886 people, like that of Liverpool occupies the shores of a single harbor. Newcastle upon Tyne, the largest and most central unit, is its natural focus. The West Yorkshire group (1,380,438) lying on the Pennine foothills of the West Yorkshire coal field is the least compact and least unified of the great conurbations. Leeds is the chief city, but it does not dominate its group as is the case with the chief cities of the other groups. It illustrates well the peculiar social problems before the conurbation, compounded as it commonly is of distinct and independent governmental units which have not realized their community of interests.

Modifications in the Western Boundary of Hungary. According to the Treaty of Trianon, Article 27 (see "The New Boundaries of Hungary," *Geogr. Rev.*, Vol. 10, 1920, pp. 408–412, with insert map scale 1: 1,500,000), the territory known as Burgenland was assigned to Austria because its population is predominantly German. But when the time came to transfer authority from one sovereignty to the other, the Hungarian government, and the local authorities as well, opposed the measure on the ground that the population opposed a change of control and that the region was historically Hungarian. To settle the dispute a conference was held to which Hungary was invited, and there resulted the Protocol of Venice, October, 1921. This document called upon the insurgent bands that had sprung up at many centers to lay down their arms, after which the Austrian government was to take possession. Allied generals were to sit at Sopron and supervise a plebiscite; and both Austria and Hungary pledged themselves to abide by the results. In sympathy with the vote the Conference of Ambassadors assigned to Hungary the town and district of Ödenburg. A further complication has now arisen in the settlement of the Burgenland dispute because the Delimitation Commission, specially appointed by the Peace Conference to establish the Burgenland boundary, has proposed, after a careful study of the whole frontier, that three additional districts should also be given to Hungary as follows: (1) the area around the village of Pamhagen, because it controls a system of irrigation and navigation canals affecting a wide area of Hungary; (2) a group of villages east and southeast of Liebing, because they gravitate around the town of Güns which remains in Hungary; (3) a narrow strip of territory, from 20 to 25 kilometers long, west of the town of Steinamanger, because its economic center is in Hungary. But the Austrian government has objected to these proposed changes in favor of Hungary though it informed the Conference of Ambassadors that it would accept any arrangement that the Council of the League of Nations might

make provided that it were made unanimously. The next step will be a study and recommendation by the Council before the Delimitation Commission can continue its work.

The Council of the League has also to consider changes recommended by the boundary commission that is establishing the line between Hungary on the one hand and Rumania and Yugo-Slavia on the other. The commission finds it necessary to depart from the terms of the treaty in some details, a contingency that was foreseen by the treaty makers who provided a means for friendly negotiation. It is only when the recommendations of the Council of the League have been accepted and incorporated by the boundary commissions that the precise limits of Hungary will be known. (For the status of the question as of June, 1922, see *Monthly Summary of the League of Nations*, Vol. 2, No. 6; and for a detailed map of the Burgenland area with boundaries in accordance with the plebiscite held under the terms of the Protocol of Venice, see *Kartographische und Schulgeographische Zeitschrift* Vol. 9 and 10, 1921, p. 136.)

AFRICA

Boundaries of the Spanish Sahara and the Ifni Enclave. The narrow belt of ocean between the Canary Islands and the African mainland is one of the world's rich fishing grounds, though only a small part of the potential wealth is realized today. A fleet operates from the Canaries, and fish are dried and salted on the mainland and carried to market in Teneriffe and Grand Canary. The industry, limited as it is, constitutes Spain's chief modern interest in the Saharan coast where lies her possession of Rio de Oro and the near-by Ifni enclave in French Morocco. Spain's historical claims over these territories go back to the fourteenth century when the Canaries and the adjacent coast across the "Mar Pequeña" were incorporated in the Crown of Castile. The chief subsequent event on the mainland was the erection of the fort of Santa Cruz de Mar Pequeña by Diego de Herrera in 1476. Thereafter interest lapsed. Claims of possession were revived in 1860 when under treaty made with the Sultan of Morocco at Tetuán Spain was granted "in perpetuity sufficient territory for a fishing station on the coast of the ocean by Santa Cruz de Mar Pequeña as she had there of old" (Jerónimo Becker y González: Tratados, convenios y acuerdos referentes á Marruecos y la Guinea Española, Liga Africanista Española, Madrid, 1918). The Shereefian Empire, however, had no control over the tribes and was itself in a precarious political situation, and Spain was unable to take possession. In 1878 a Hispanic-Moroccan commission was appointed to define the territory and began work by instituting a search for the lost site of Santa Cruz de Mar Pequeña (García Pérez: Santa Cruz de Mar Pequeña y Sahara occidental, *Revista Gen. de Marina*, Vol. 45, 1922, pp. 435–455, Madrid). The coast was examined from Agadir to Puerto Cansada near Cape Juby, which latter has been generally identified with Diego de Herrera's fort. The Spanish commissioners, however, favored Ifni; and this point was eventually accepted. The Franco-Spanish conventions of 1904 and 1912 settled the limits of the territory, giving it an area of nearly 1,000 square miles.

The middle of the last century also saw a certain manifestation of Spanish commercial interest on the Saharan territory bordering the coast, and early in 1885 Spain communicated to the powers her intention to establish a protectorate over the region from Cape Blanco to Cape Bogador. The following year by treaty with Arab chiefs (Treaty of Ijil) she acquired a sphere over the western Sahara stated to cover some 270,000 square miles. But here she came into conflict with France pushing northward from the Senegal. The convention of 1900 settled the common boundary of French and Spanish possessions as far north as the latitude of Cape Bogador (26°), curtailing the Spanish claims and awarding to France the valuable salt beds of Ijil. This treaty made provision for free export of native salt, mutual fishing rights in the Cape Blanco peninsula region, and for French right of preëmption over the Spanish possession.

The convention of 1904 defined the sphere of influence from 26° to the parallel 27° 40′ accepted as the southern limit of Morocco, and also a sphere in southern Morocco to and beyond the Draa. The Spanish rights west of the line were confirmed by the convention of 1912 with the exception of the territory beyond the Draa, which was made the southern boundary of Morocco. Spanish Sahara was thus cut off from Ifni. While thus settled in general terms the eastern frontier of Spanish Sahara has never been defined. All this time France had continued her policy of penetration and pacification, her aim being to establish connection between her west and north African domains. As the "corridor" of Rio de

Oro is not available, connection must be made across a stretch of difficult country, the "great desert" between the Adrar section of Mauretania, brought under control in 1913, and Algeria. Conjunction between the camel corps of these two areas has been recently reported ("La liaison de l'Afrique occidentale française avec l'Algerie," *Renseign. Colon.* (*Suppl. à l'Afrique Française*, November, 1921). The several Trans-Saharan railway projects recently brought forward in France include one across Mauretania (Général Calmel: Le Transmauritanien, Paris, 1921) which would call for certain boundary modifications. Meanwhile the Spanish domain has remained practically undeveloped, and authority over the interior is very imperfect. Most of the population is nomadic and moves to and fro across the frontier, and France complains of raids proceeding from Spanish territory. A French view of the situation is presented by Étienne Richet in his book "La Mauritianie" (Paris, 1920) wherein the Spanish colony is described as limited to "a simple fishing station." The Canary islanders have transactions at various points of the coast, but the only Spanish settlement is Villa Cisneros, a "citadel fortress," so little connected with the hinterland that even the water supply is brought monthly from the Canary Islands.

The Population of Southern Rhodesia. It appears certain that the British South Africa Company's rule over Southern Rhodesia must give way to either responsible government or union with South Africa. In view of the pending political change the 1921 census of white population is of special interest (*The African World*, June 24, 1922, p. 327). That the country has not yet emerged from the pioneer stage is shown by the nature of the last decennial increase—42 per cent (as compared with Great Britain 4.7; South Africa 19.2; Canada 20.2, Australia 21.8) of which 17.7 per cent represents natural increase. Yet a trend towards the demographic conditions of a settled population is apparent. Thus, while the percentage of males was 66 in 1911, it is now 56; and, where 64 per cent of the male population of 1911 was between the ages of 20 and 44, it is now 43. The origin of the population is also of interest. In 1911 49 per cent came from Europe, 46 per cent from Africa; in 1921 the respective percentages were 36 and 60.

The total white population of 33,620 (incorrectly given as 36,000 in *The African World*) is, however, very small by the side of the Bantus, estimated to number nearly 800,000. This great native population constitutes one of the serious problems before any new administration ("The Rhodesian Question," *Round Table*, December, 1921). It would prove a heavy burden for a self-governing state and no light matter for the Union of South Africa, which, as the President of the South African Association for the Advancement of Science for 1921 has pointed out, is "a country excelling in sociological problems, racial and interracial, national and international. No other country in the world has so many distinct races and nations settled within its borders, and at such diverse stages of social evolution" (J. E. Duerden: Social Anthropology in South Africa: Problems of Race and Nationality, *South African Journ. of Sci.*, December, 1921). Preliminary figures for the 1921 census place the white population of the Union at about a million and the colored (chiefly Bantu) at nearly five and a half millions.

ASIA

The Agriculture of the Ifugao. In a review of A. L. Kroeber's "Peoples of the Philippines" (*Geogr. Rev.*, Vol. 11, 1921, pp. 462–463) reference was made to the interesting case of the Ifugao of Luzon whose agricultural skill is remarkable among primitive peoples. A detailed account of their agricultural practices in relation to tribal economy has recently been given by R. F. Barton ("Ifugao Economics," *Univ. of California Publs. in Amer. Archaeol. and Ethnol.*, Vol. 15, 1922, pp. 385–446).

The Ifugao dwell in the valleys and pockets of the rugged slopes in the northeastern part of the Cordillera Central. Not only are they separated from centers of civilization by several days' troublesome journey, but even among themselves valley has had little relation with valley save through war and blood feud. Economically they are almost self-sufficient. An analysis of their food sources shows only .024 parts from importation; agriculture provides .84 parts, wild foods .094, and animal culture .042 parts. The food staples are camotes (sweet potatoes) and rice. Camotes require less cultivation, for they do not require irrigation nor do they require a fertile soil. But, though they constitute the larger proportion of the food supply, they are not valued as is rice. His rice crop is the measure of a man's social status in Ifugaoland. It used to form his currency. His religion centers

around it. To obtain good weather for crops a great number of feasts are held at which pigs, chickens, and other animals are sacrificed. To provide these furnishes the chief economic motive. The varied and uncertain weather does indeed call for special intervention. Compared with other parts of the islands there is little sunshine. The annual rainfall is heavy, 100 to 125 inches. The rice-growing period here, February to June, is what in most other provinces is the dry season. The nearest approach to a dry season is during March and April when the rice fields sometimes suffer. Rice is grown on the irrigated terraces which sometimes climb the hillsides from elevations of 2,500 to 5,000 feet. The altitudinal range over which rice is grown leads to a certain mobility of labor, the workers moving from lower to successively higher fields for planting and harvest. Retaining walls may be over 20 feet high for fields less than 11 feet wide. Careful spade cultivation and careful selection of seed lead to the production of crops of excellent quality. The rice grains of Ifugao are said to be largest to be found anywhere.

AUSTRALASIA AND OCEANIA

Glacial Erosion in New Zealand. In a recent bulletin of the New Zealand Geological Survey (Geology and Mine Resources of Western Southland, *Bull. 23*, 1921) an explanation of the great fiords of the southwestern coast of South Island is given by James Park. The mountain belt of South Island consists of uplifted and dislocated fault blocks, the surface of which—a peneplain surmounted by subdued mountains—is much modified by normal and glacial erosion. The fiords are regarded as due to glacial enlargement and deepening along valleys of normal erosion guided by faults. "The rounded and flowing contours of the mountains, the U-shaped valleys, cirques, truncated spurs, hanging valleys, mountain tarns, and rock basins are evidence of intense Pleistocene ice erosion. In the molding and modifying of the land the ice has evidently removed an immense amount of material," yet in the fiords "there is a conspicuous absence of ice-carried débris." Quotation is made from a report by Hector in 1863, showing an early recognition of glacial erosion in this region: "The lateral valleys join the main one at various elevations but are all sharply cut off by the precipitous wall of the [Milford] Sound, the erosion of which was no doubt continued by a great central glacier long after the subordinate and tributary glaciers had ceased to exist." This approaches but does not quite reach the modern understanding of the hanging-valley problem.

Significant details concerning the incomplete glacial erosion of overdeepened troughs in the alpine region of southern New Zealand are given by R. Speight of the Canterbury Museum, Christchurch, N. Z., in an essay on "The Modification of Spur-Ends by Glaciation" (*Trans. and Proc. New Zealand Inst.*, Vol. 53, 1921, pp. 47–53). The preglacial form of the mountains was sub-mature; "valleys had been cut in an elevated area, and a well developed stream-system had been established with long spurs trailing down into the main valleys." As one enters the valleys, the spurs outside of the glaciated area still preserve long trailing forms; a short distance inside the glaciated area the spurs are moderately notched; farther in, the notches increase in depth and divide the spurs into a series of rounded knobs; farther still, the spurs are more or less completely removed, the knobs being greatly scoured away where they still survive and the spur ends being strongly truncated.

W. M. DAVIS

POLAR REGIONS

An Expedition to Jan Mayen Island. The Island of Jan Mayen, lying between Iceland and Spitsbergen, shares the fate common to remote islands of discovery and rediscovery, legendary and authentic. The first discovery has been attributed to the much-traveled Saint Brendan, a thesis recently supported by Dr. Charcot, of the *Pourquoi Pas*, who visited Jan Mayen in 1902 and 1912 and 1913 ("Au sujet de l'île de Jean Mayen," *Comptes Rendus de l'Acad. des Sci. [de Paris]*, Vol. 172, 1921, March 14, pp. 669–670). Doubtless the island was known to the early Norse voyagers whether or not it is the "Svalbard" of the Icelandic sagas. Its rediscovery dates to the time when the northern waters acquired importance as a whaling ground in the early seventeenth century. English and Dutch, rivals on the fishing grounds, were rivals for the discovery. Hudson has been accredited, but it appears now that the honor goes to the Dutchman Jan Jacobsz May for his voyage of 1614, though he was close followed by the Englishman Robert Fotherby (1615). While

the fisheries maintained their importance Jan Mayen with Spitsbergen was a scene of activity; since then it has been visited by occasional whalers and sealers and, during the last century, has attracted a certain amount of scientific attention. Most observers, however, have spent only a short time on the island; and some parties, indeed, failed to land by reason of the ice or weather conditions along its inhospitable shores. Such was the case with the Stackhouse Expedition of 1911 (*Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 881–890). Our chief source of information has been the work of the Austrian party that maintained there one of the International Circumpolar stations in 1882–1883.

Last year a successful expedition to Jan Mayen was conducted by Mr. J. L. Chaworth-Musters of Cambridge University. Mr. J. M. Wordie, who accompanied the expedition as geologist, gives an account of its operations in the March number of the *Geographical Journal*. The prime objects were to make natural history collections supplementary to those of the Austrian party and to climb Beerenberg.

Jan Mayen is a volcanic island of comparatively recent origin. The mountains of the southwestern end are moderately subdued. At the northeastern end is the beautiful cone of Beerenberg, with the exception of certain nunataks of Greenland the loftiest mountain within the Arctic. The formation of Beerenberg is among the last events in the physiographic history of the island, though it has not been active in historic time. Ascent of the mountain was accomplished and its height established, by aneroid, as 8,090 feet against the theodolite measurement of 8,350 feet by the Austrian party. The diameter of the crater was estimated at half a mile, and the depth as 500 to 800 feet. On the northern side the crater is breached by a gap through which emerges the Weyprecht glacier in a "series of wonderful falls." The mountain is almost completely covered with snow and ice, and the glacial system is of special interest. A summary statement regarding it is given by Professor Mercanton, the eminent Swiss glaciologist who accompanied the expedition (*Comptes Rendus*, Vol. 174, 1922, June 6, pp. 1479–1481). The entire system appears to be in retreat; icebergs are no longer calved from those glaciers that reach the sea, despite their crevassed fronts; and some lobes no longer reach the sea.

Jan Mayen is of no direct commercial interest today; indirectly, however, it has significance as a weather forecasting station. The importance of the island in this respect was pointed out by the International Aerological Polar Commission meeting at Copenhagen in 1914 and subsequently by the Norwegian Geophysical Commission ("Various Papers on the Projected Co-operation with Roald Amundsen's North Polar Expedition," *Geofysiske Publikationer*, Vol. 1, 1920, No. 4, Christiania). Jan Mayen lies in the Icelandic low at a quarter whence proceed the frequent northwest gales that do much damage to Norwegian coastwise shipping. The Norwegian government decided to support the experiment urged by Norwegian scientists. Mr. Chaworth-Musters' expedition was accommodated on the vessel carrying a party under Engineer Ekerold to erect a wireless weather station. The station, which has now been in operation for nearly a year, has proved a notable success (note on Jan Mayen in *Geographical Journal*, June, 1922, p. 475) and will be continued.

The Vegetation of Western Greenland. A summary of our present knowledge of the vegetation of western Greenland is given by R. E. Holttum in the May number of the (British) *Journal of Ecology*. The strip of ice-free land on the west of Greenland is characterized by an oceanic climate. The mean annual temperature ranges from 1° C. at the southern tip to −8° C. at Upernivik, latitude 73° N., the most northerly Danish colony: July temperatures from 10° C. to 5° C. respectively. Precipitation diminishes northward from 50 inches at the southern extremity to 8 inches at Disko and 9 inches at Upernivik. Summers are cool and damp with sea fog common at sea level, conditions being uniform over a long stretch of coast. The July isotherm of 10° C. is approximately coincident with the northern tree limit; hence tree growth can be looked for only in the extreme south. In Tasermuit Fiord (latitude 60° N.) birches grow to the exceptional height of 20 feet. As far north as the 62nd parallel the climax vegetation appears to be a birch-willow scrub. The birch (*Betula odorata*) is usually very thick but rarely reaches a height of 16 feet; the willow scrub (*Salix glauca*), which occupies the moister and less sunny places, may attain a height of 2½ feet but normally is not half that. Heath and grassland are also extensive.

North of latitude 62° N. heath is the dominant formation. It flourishes to considerable altitudes, on Disko Island, for instance, to above 2,000 feet. It is composed essentially of low woody plants of which the most important are the so-called Arctic heath (*Cassiope tetragona*) and the curlewberry (*Empetrum nigrum*). Where the climatic conditions are

less favorable heath gives way to an open formation, the fell-field of isolated stunted flowering plants with mosses and lichens. This is the characteristic vegetation of the nunataks and the extreme north (compare a popular account by W. Elmer Ekblaw: The Plant Life of Northwest Greenland, *Natural History*, Vol. 19, 1919, pp. 272–291, and the appendix on "Flora and Fauna on the North Coast of Greenland" in Rasmussen's "Greenland by the Polar Sea," reviewed in this number of the *Geogr. Rev.*). In favorable sites where there is an adequate snow cover in winter and protection from cold dry winds, as along sides of streams, willow scrub or a herbaceous vegetation may be found. Moss bogs occur on wet undrained soils, and there are special edaphic formations of salt marsh along the shore and a luxuriant vegetation round the settlements ancient and modern.

The Northernmost Mountain Range. A partial report on the Second Thule Expedition of 1916–1918 by Lauge Koch gives a good account of the structure of northwestern Greenland ("Stratigraphy of Northwest Greenland," *Meddel. fra Dansk Geol. Forening*, Vol. 5, 1920, No. 17). It appears that the greater part of the ice-covered area consists, judging by exposures along the coast, of a rather even foundation of crystalline rocks overlaid by ancient horizontal strata; but that the northwest coast, from Cape Morris Jesup to Robeson Channel and across it into Grant and Grinnell Land, has the structure of an ancient mountain system of folded and greatly denuded strata, now cut across by many fiords and thus resolved into as many promontories from 1,000 to 2,000 meters high. It is the northernmost mountain range in the world. Koch associates it with the ancient mountains of Scotland, Norway, and Spitsbergen. W. M. Davis

WORLD AS A WHOLE AND LARGER PARTS

The Mapping of Latin America. At the meeting of the British Association held at Hull early in September Mr. Alan G. Ogilvie read a paper on this subject before Section E (Geography). Mr. Ogilvie exhibited a new map in provisional form on which the present state of cartographic knowledge is represented. This map represents a part of the work carried out by the American Geographical Society in its Hispanic American division. It is hoped that its publication will be a real step in the direction of accuracy of expression. It is exceedingly difficult to determine from internal evidence the reliability of most of the existing maps of Latin American countries, and they are rarely accompanied by adequate indications of the materials from which they are compiled. This index map then, which is largely based on examination of original sources, will form a useful finger post, warning against the too easy acceptance of many maps which do not reveal their chief faults to those who have no means of checking their accuracy.

The process of mapping America south of the Río Grande del Norte has hitherto passed through three phases. The Colonial period from the discovery down almost to the birth of the independent nations was marked by much exploration and approximate mapping of the main features. The second phase corresponds to the explorations of eminent European naturalists led by Alexander von Humboldt whose interests were wide, but with whom the improvement in cartography was but one of their aims. The third phase has been marked by the operations of an ever increasing number of explorers whose main object has been the provision of more accurate maps.

At the present time the most reliable surveys in different regions have been carried out from several different motives. Thus, many long and important traverses and some areal surveys have been made by men—mostly Europeans—with a passion for exploration. The governments of mercantile states, primarily Great Britain and France, have accurately charted the coasts. Boundary disputes involving political and strategic questions have occasioned several of the most extensive and accurate surveys hitherto carried out in South America. But more and more it is the economic development of the continent which calls for accurate mapping, and in the future we may expect that survey by scientific methods will precede not only the building of railroads and opening of mines but the settlement of agricultural and even pastoral land. As boundaries become settled, and causes for war are removed, it will be the economic development of the various countries which will maintain the geodetic and topographic services of states which already possess them, such as Mexico, Argentina, and Chile, and will lead to the creation of such services in the states where they now are absent. Amongst the economic purposes which have already led to the mapping of important areas of Latin America the following may be specially mentioned:

railway surveys, especially in Mexico, Chile, Argentina, and eastern Brazil; in Peru, river surveys with the aim of establishing navigational outlets to the Amazon, and areal surveys of river basins in the Maritime Andes with a view to irrigating parts of the coastal deserts; surveys of possible oil territories in Mexico, Central America, Colombia, Venezuela, Peru, and on the eastern fringe of the Andes in Bolivia and Argentina; while our map knowledge of Central America rests mainly upon the surveys preceding the selection of routes for the interoceanic canal, and for an intercontinental railroad, supplemented by the data of the fruit-growing companies and the route traverses of a few veteran explorers. In Brazil the economic status of the various states is to some extent reflected in the state of their maps—São Paulo alone being largely covered by systematic survey. But the need of communications between the two contrasted divisions of the Republic has led to important explorations about the southern tributaries of the Amazon and their sources.

An interesting—if obvious—fact is revealed by the map referred to at the beginning of this note; namely that nearly all the lands in which areas of any size as opposed to mere routes have been surveyed lie in the unforested regions of South America or in regions of open woodland. The great Amazonian forest is today marked on the map by a relatively small number of known arteries—its rivers; and few of these have yet been surveyed by accurate methods.

The Air Route from Cairo to Baghdad. Extensive use of aircraft in the Near East during the war has been followed by the establishment of a regular air connection between strategic points in this section of the British Empire's most important line of communications, the road to India. The significance of the Cairo-to-Baghdad air service is illustrated in the saving of time on the mails. Ordinarily a letter from London to Baghdad travels via the Suez Canal, the Red Sea, Bombay, Karachi, the Persian Gulf, and Basra—taking between five and six weeks. The establishment of an airplane service between Cairo and Baghdad has reduced this to a minimum time of 9 days.

Two interesting descriptions of the route have recently appeared, "Some Notes on Aeroplanes, with Special Reference to the Air Route from Cairo to Bagdad," by Air-Commodore H. R. M. Brooke-Popham (*Journ. Central Asian Soc.*, Vol. 9, 1922, pp. 127–146, London) and "By Air to Baghdad," by H. T. Montague Bell (*The Near East*, No. 575, Vol. 21, 1922, May 18, pp. 669–674). From Cairo, which seems destined to be one of the world's chief centers of aerial transport, the route proceeds northeast, crossing the Suez Canal at Kantara and passing over Jerusalem and the "inhospitable" Judean hills and the Jordan about its entry into the Dead Sea. Amman, on the Hejaz railway and capital of Trans-Jordania, is an important way station beyond which the route enters on the 500-mile stretch of the Arabian desert. The undulating surface of the desert is over 2,000, in some places over 3,000, feet above sea level and for the first hundred and more miles shows bare lava outcrops alternating with yellow mud flats, "level as a billiard table," covered with water in the rainy season. Traces of an ancient civilization are seen in the lava country. Beyond is a poor steppe country grazed over by nomad Arabs after the rainy season (winter and early spring) and even in summer the theater of occasional raids. Halfway between Amman and Baghdad the two wells known as El Jid form one of the two or three permanent watering places in the desert route.

It was necessary to mark the air route over the comparatively featureless desert country, and this has been accomplished in an ingenious fashion by passing a number of heavy motor lorries over the same track. The track can easily be picked out at elevations of 3,000 to 8,000 feet and need be renewed but once a year. The first half of the course from Amman to El Jid was executed and mapped by Dr. Ball, of the Egyptian Survey; the second half by the Royal Air Force. The marking of the track in June, 1921, was the first known European crossing of this portion of the Arabian desert. Northward lies the well-known caravan route through Damascus (compare Sir Ross Smith's flight over Damascus, in "From London to Australia by Aëroplane," *Natl. Geogr. Mag.*, Vol. 39, 1921, pp. 229–339); but its course is not available to military planes because it crosses into the French sphere.

Meteorological conditions encountered in flying across the desert offer points of interest. The journey east-bound is normally accomplished in less time than west-bound, for at an elevation of 1,000 feet above the surface the westerly wind is apparently permanent. Near the surface sudden changes of wind are characteristic. The worst meteorological trouble seems to be the dust storms, which are not only of frequent occurrence in the warmer months but extend upwards to great elevations — according to Air-Commodore Brooke-

Popham, to heights of 12,000 feet. The formation of dust in the neighborhood of Samara on the Tigris is described in a recent memoir by C. W. B. Normand ("On Dust-Raising Winds," *Memoirs Indian Meteorol. Dept.*, Vol. 22, Part VII, 1921, Calcutta).

HUMAN GEOGRAPHY

The Cold of the Tropics in Relation to Health. The same "passion for simplicity" that fosters the idea of an Arctic climate always and everywhere intensely cold (V. Stefansson: Some Erroneous Ideas of Arctic Geography, *Geogr. Rev.*, Vol. 12, 1922, pp. 264–277) accepts the idea of tropical climate as "unhealthy." This view is challenged by F. L. Hoffman in a short article "Climate and Health in the South American Tropics," in the January number of the *Monthly Weather Review*. Mr. Hoffman, whose statistical work in relation to health and mortality is well known, has recently spent some time in northern South America. He sees no reason "why a so-called tropical climate should be *per se* an unhealthy one. Tropical heat, of course, gives rise to tropical parasitical life with its resulting evil pathogenic effects upon the human organism. But such diseases as result indirectly from tropical heat and moisture can now be effectively guarded against by the intelligent observance of ordinary rules of living." The chief deleterious effect of the climate is cold — the cool, often "distressingly" cool nights. "The chief causes of ill health and premature death in northern South America are not tropical diseases but respiratory and rheumatic affections, which prevail to an enormous extent among the native population. The sensible temperature at night is at times extremely trying and guarded against only by an abundance of covering, which is usually wanting in the case of the native population. Houses are poorly constructed, and the draughts during the night chill the body to a point where disease resistance reaches its lowest ebb. Coughs and colds are of practically universal occurrence, and no precautions are employed on the part of the natives, who are improperly fed, improperly clothed, and improperly housed. The resulting high mortality is not chargeable to the climate, but to apathy and indifference and colossal ignorance."

In Mr. Hoffman's experience the most trying period is between 2 and 3 in the morning when the temperature may be 30° or more lower than in the daytime. Actual instrumental records are scant from the region in question, but such as exist are amply illustrative. For instance at Santo Anato in the Urubamba valley of Peru, a little below 2,000 feet in altitude, in August a daytime maximum of 92° was followed by a minimum of 54° (Isaiah Bowman: The Andes of Southern Peru, p. 178). Other examples are quoted by S. S. Visher in an article "Variability and Uniformity in the Tropics" (*Scientific Monthly*, Vol. 15, 1922, pp. 23–35). On the dry western sides of the Fiji Islands temperatures below 40° have been recorded near latitude 16° close to sea level. Besides the regular and marked cooling of the tropical night the uniformity of tropical temperatures may be broken by irregular "cold spells." A striking illustration is the characteristic occurrence of westerly and northwesterly gales on the Venezuelan coast from December to mid-March which last several days and bring temperatures of 45° or even less (*Meterol. Mag.*, Vol. 56, 1921, p. 42).

Tropical variations in wind, rainfall, and storminess are also discussed by Mr. Visher with the object of correcting a general overemphasis on tropical uniformity arising from conventional statements based on averages.

Aerial Navigation in Its International Aspects. The Convention for the Regulation of Aerial Navigation held at Paris in October, 1919 (*Treaty Series No. 2, Cmd. 1609*, London, 1922) marks a stage in the history of international communications. The convention is adhered to by 27 Powers. Its chief result is provision for the institution of the International Commission for Air Navigation. In addition to its executive function the commission is charged with matters of specific geographical interest; to collect meteorological and other information of interest to international air navigation and to ensure the publication of maps for air navigation in accordance with standard requirements.

The maps embrace two types, general and local, the index scheme being based on that adopted for the international millionth map, and units of measurement, colors, symbols, and arrangements are to conform with the millionth map as far as practicable. The general maps are to be drawn on the Mercator projection and to a scale of 1 degree of longitude equals 3 centimeters. Each will bear the heading "Carte générale aéronautique internationale," a translation of this heading in the language of the country publishing the map,

and an appropriate geographical name. It will show at least the following data: principal physical features and geographical names; wireless stations; marine lighthouses (height and range at sea level, color and character of the light); national frontiers; prohibited areas; principal air routes; lines of equal magnetic variation; south polar distance; latitude, old and new notation of longitude (see local maps), with an outer margin containing letters and numbers referring to the index of the millionth map; legend of symbols in English or French and in the language of the country publishing the maps; publisher's name and date of publication and of successive editions.

The local maps are to be drawn to a scale of 1:200,000 or, in the case of sparsely inhabited countries, 1:500,000 or 1:1,000,000 as may be appropriate. In addition to the usual notation they will show a new grid reckoning which, with regard to latitude, commences at the South Pole as zero and increases northward by degrees and minutes to 180° at the North Pole and, with regard to longitude, commences with the antimeridian of Greenwich as zero and runs eastward by degrees and minutes to 360°. The local maps are to comprise one degree of latitude and one degree of longitude. The local sheets are to show as far as data are available the following: twenty-minute projection grid; roads divided into two classes according to their relative visibility from the air; railways of all kinds; cities and towns in outline and the plan of the principal public roads crossing them (villages similarly if practicable, otherwise their positions indicated); principal features of the surface water system; woodlands and other areas unsuitable for landing; aerodromes; hangars for airships; plants for balloon inflation; permanent landing places on ground and water; aeronautical ground marks (beacons and fixed navigational lights); marine lighthouses (height, range at sea level, color and character of the light); wireless stations; meteorological stations; overhead electric power lines; remarkable objects; national frontiers; the frontier crossings for customs purposes; prohibited areas; principal air routes; names of important bodies of water; towns and important villages; the topographical relief by shading and figures indicating heights, the most important of which to be surrounded by an oval ring.

As the ordinary topographic mapping is inadequate for aeronautical maps, it is suggested that steps be taken to survey from the air areas along the most important international routes.

Three classes of meteorological information are to be furnished: (1) statistical, to indicate the degree of safety and convenience of routes and aerodromes; (2) current; and (3) forecasts for various periods and for routes. The forms for reports and codes for transmission are given.

GEOGRAPHICAL NEWS

Personal

Professor Albert Perry Brigham of Colgate University gave a course of lectures on America before the Oxford University School of Geography at its summer meeting. The subjects were: The American Domain, Distribution and Racial Character of the Population, Education, and Social and Political Ideas.

Obituary

H. S. H. Albert I, Prince of Monaco. Oceanography suffers a loss by the death in Paris on June 26 of the Prince of Monaco. The Prince leaves a permanent memorial in the form of three well-equipped scientific institutions, the Musée Océanographique in Monaco, the Institut Océanographique in Paris, and there also the Institut de Paléontologie Humaine—the last a testimonial to the benefactor's personal interest in prehistoric archeology as well as in all things oceanographical. The museum collections, especially that of the Cetaceae, testify to the Prince's prowess as hunter and naturalist; the exhibits of apparatus, many devised by him, to his practical knowledge as sailor and mechanical engineer; the splendid series of publications emanating from the Press at Monaco, to the wide range of oceanographic interests that he has fostered. The publications render available the results of the many annual cruises of the Prince's yachts, in the northern Atlantic and Mediterranean, and are planned to serve similarly for the work of the recently founded Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée, of which the Prince was president.

The phase of the Prince's work that has perhaps attracted the widest attention is that on

the currents of the northern Atlantic: one of his last published contributions to science was a study of the probable drift of mines in these waters based on the course of floats dispersed from the *Hirondelle* in 1885–1888 (see the note in the *Geogr. Rev.*, Vol. 10, 1920, pp. 419–420). His work as a whole has been summarized in the words of the inscription on the Cullum Geographical Medal of the American Geographical Society awarded the Prince in 1921. "By intensive exploration and by research and publications of the highest order he has advanced the science of oceanography and extended man's knowledge of the sea and its resources."

ROLLIN D. SALISBURY. In the death of Professor Salisbury on August 15 at the age of 64 a severe loss is sustained by the departments of geology and geography of the University of Chicago. Professor Salisbury had been associated with the University since 1892. He was dean of the Ogden School of Science since 1894, head of the department of geography from 1903 to 1919, and since then head of the department of geology. Professor Salisbury's main interests have been in physical geography. His original work has been done largely in glacial geology, but he was first and foremost a teacher, and his most valuable contributions are the many textbooks of which he was sole or joint author. These include "Physiography," of which the first edition was published in 1907, the third in 1919; with Thomas C. Chamberlain, "Geology," 2 vols., 1904, 1906; "The Interpretation of Topographic Maps," *U. S. Geol. Survey, Professional Paper No. 60*, 1908, written in collaboration with Wallace W. Atwood, which has proved a valuable adjunct in physiography teaching; with H. H. Barrows and W. S. Tower, "Elements of Geography" (1912). Professor Salisbury was joint editor of the *Journal of Geology*. He was a member of the Association of American Geographers and acted as its president in 1919.

MR. LEVI HOLBROOK, Councilor of the Society, died on July 26, aged 86 years. He became a Fellow of the Society on December 17, 1872, and a Life Fellow on May 14, 1889. He was elected to the Council in January, 1888, and served as the Secretary of the Council from February 1, 1890, to February 15, 1912. For many years he was Chairman of the Lecture Committee and from time to time served on various special committees appointed by the President.

GEOGRAPHICAL REVIEWS

Exploration in Central Asia

Aurel Stein. **Serindia: Detailed Report of Explorations in Central Asia and Westernmost China.** Vol. 1, xxxix and 547 pp.; ills., bibliogr.; Vol. 2, viii and pp. 549–1088; ills.; Vol. 3, xi and pp. 1089–1580; maps, diagrs., ills., index; Vol. 4, x pp. and 175 pls. 1 portfolio (Vol. 5) with 94 maps. The Clarendon Press, Oxford, 1921. 13½ x 10½ inches.

The most important work upon Central Asia that has appeared in many a day is "Serindia," in which Sir Aurel Stein gives us the long and eagerly awaited report of his explorations, mainly archeological but also to a very considerable extent geographical and ethnological, during his second Central Asian expedition, in 1906–1908. It embraces the full record of two and a half years of arduous but most profitable labor in that region to which French scholars refer as Sérinde, between the Pamirs on the west and the Pacific watershed on the east, where the Indian and Chinese cultures have met. The particular period to the study of which the author mainly devoted himself was that relatively brief but intensely interesting one, covering in all but a few centuries, when the Buddhist faith, modified to a certain extent by transmission through the hands of Iranian intermediaries, was being carried across the Central Asiatic regions to China, Korea, and Japan.

The work carries us step by step along the author's route from the time he left the Peshawar border, through his various stages past the southern rim of the Taklamakan to northwestern China proper, and then back by way of the old northern route. For the personal incidents of travel Sir Aurel refers us to his "Ruins of Desert Cathay," which appeared in 1912, and which those not already familiar with it would do well to read in conjunction with "Serindia" in order to get a full conception of the arduous character of the expedition and the hardships and dangers encountered in its course.

The earlier portion of the route by which Sir Aurel proceeded from India to the scene of his labors is of interest for its association with Alexander's career. In this connection the author makes numerous interesting comments; but he holds out little hope (pp. 2 and 4) of the certain identification of many of the more important sites mentioned by historians, such, for example, as Massaga, or the still more famous Aornos. The Indian character of the population found by the Macedonians in the Kabul valley is pointed out—an indication of a very definite shifting toward the Indus, during the past two thousand years, of the linguistic and cultural, if not the actual ethnic, boundary between India and Iran. Perhaps in some way connected with this has been a distinct recession of the Iranian frontier on the east and northeast. One result of the Central Asiatic explorations of the past few years—a result to which Sir Aurel has himself contributed in no small measure—has been to demonstrate the former much greater extension eastward of the Aryan-speaking peoples, even as far as the borders of China proper. It seems to be demonstrated that as far eastward as Khotan and even farther, toward the Tun-huang oasis, forms of Iranian were spoken as late as the eighth century, not dying out completely indeed until about the end of the tenth. What the Iranians have won on the southeast they have lost, and more than lost, in the direction of Central Asia.

The second and third sections of this first chapter give a sketch of that Chinese contact with northwestern India for our knowledge of which we are indebted to the accounts of the travels of Buddhist monks like Fa-hsien, early in the fifth century, and the better-known Hsüan-tsang, in the seventh. Readily comprehensible is Sir Aurel's enthusiasm for the self-devotion and fortitude displayed by these simple Chinese monks in their journeys across the Central Asiatic deserts and mountains to the homeland of their faith; for nowhere and at no time have men displayed greater readiness to undergo privation and danger in their search for the truth.

Chapter 2 offers us (pp. 52 ff.) an account of the eighth-century Chinese conquest of Yasin and Gilgit, a feat which included the crossing of the Pamirs and the Hindukush by an army of 10,000 men and which reflected all the greater credit upon their leader, General Kao Hsien-

chih (his name deserves to be remembered) because of the poor quality and low morale of his troops. The Chinese have more than once shown in the conduct of their military operations among the great mountain masses of Central Asia a genius which makes the crossing of the Alps look like child's play by comparison; witness their invasion of Nepal late in the eighteenth century, when after advancing over two thousand miles from their base, by a road which led across the inhospitable tableland of Tibet, they conquered on its own soil one of the finest fighting nations in India.

In the ninth chapter occur important historical notices on "Lop, Shan-shan, and Lou-lan" (pp. 318 ff.), while the next, entitled "Through the Lop Desert" (pp. 346 ff.) is of especial interest from the geographical point of view. It is worth while noting that in one of the sections of the latter chapter, "Across an Eroded Ancient Delta," as well as here and there elsewhere in the book, one finds recorded the picking up, on wind-eroded surfaces, of stone implements, some of them Neolithic and others possibly, although by no means certainly, Paleolithic. The prehistoric period in Central Asia, less spectacular in the character of its remains than the Buddhist epoch but of vastly greater importance to a proper understanding of the culture development not only of the region itself but also of those adjacent areas between which it has always played the part of a bridge, is one which calls most urgently for investigation. Only thus, for instance, can we hope ever to reach any solution of the beginnings of Chinese civilization.

Chapters 14–20, forming the first seven of the second volume, deal mainly with geographical matters and give us an account of the author's journey from the Lop region eastward to the Tun-huang oasis. These portions of the work tell us much that is entirely new regarding the western end of that old Chinese system of frontier defense which we call comprehensively the "Great Wall." Sir Aurel points out (p. 552) the former importance of Tun-huang as the westernmost outpost of China and the base for her earliest Central Asian operations. The third section of Chapter 14 contains some interesting remarks upon Marco Polo's journey through these same regions, while in Chapter 20 is described the identification of the site of the famous Yü-mên, or "Jade Gate," once the chief frontier town hereabout and the outlet through which passed all traffic with the west by the ancient Lou-lan route, including the export trade in silk to Parthia and the Roman Orient, treated of in the fifth section of this same chapter.

The attainment of one of the main goals of the expedition, the "Caves of the Thousand Buddhas" (Ch'ien-fo-tung), lying a few miles southeast of Tun-huang, is graphically described in the twenty-first chapter, while in the one following, "Exploration of a Walled-up Hoard," is the account of one of the most extraordinary manuscript finds of modern times, in one of the artificial caves of this site. To quote the author's own words, "The sight disclosed within made my eyes open wide. Heaped up in closely packed layers, but without any order, there appeared in the dim light of the priest's flickering lamp a solid mass of manuscript bundles rising to a height of nearly 10 feet. They filled, as subsequent measurement showed, close on 500 cubic feet, the size of the small room or chapel being about 9 feet square and the area left clear within just sufficient for two people to stand in" (p. 808).

Volume 3, the last of the text, has to do with the return journey of Sir Aurel by the old north road, via Hami and Turfan, as far as Kucha, where he took a "short cut," as he calls it, across the Taklamakan desert to Khotan and thence to India and home.

The series of appendixes at the close of the text in this volume consists of essays by various authorities on different portions of the material gathered by Sir Aurel Stein on this expedition and covers no less than 145 pages. As with the text proper, their scope is far too broad to allow of more than a mere sampling of their contents. Appendix C, by T. A. Joyce (pp. 1351–1389) discusses the physical anthropology of Chinese Turkestan and the Pamirs. Following it is a description, by Sir Arthur Church, of specimens of mural painting and plaster from various sites, mainly Buddhist. Appendix E contains three essays by the late Raphael Petrucci, as well as a brief but illuminating sketch by Laurence Binyon (pp. 1428–1431) of the art of the Tun-huang paintings.

The fifty-nine excellent plans of sites, ruins, etc., with which this third volume concludes deserve the highest commendation both for the evident care with which they were drawn up in the field and for the way in which they are presented here.

Of the 345 half tones in the text, all are finely executed and truly illustrative in the best sense; the scenes among the great snow mountains in particular reflect rare credit on the photographer not only for his technical skill but for his artistic sense as well.

The fourth volume contains 175 excellent plates representing finds of every description. A considerable number are in color, the workmanship here being of the same high standard as all else about the book.

The final "volume" is in reality a portfolio of maps, most adequately arranged for convenience of reference. In addition to one general map and an index map (the latter a most useful feature), both on a scale of 1 : 3,000,000, there are ninety-four others on a scale of 1 : 253,440, or 1 inch = 4 miles; many of these are of no little importance geographically.

A most praiseworthy feature is the list of titles on the region under consideration, together with the abbreviations under which they are cited (pp. xxv–xxviii). No less to be commended are the detailed descriptions of finds, inserted in the text as additional sections appended to the chapters with which they have to do; in this way the text is relieved of much detail that would render it distinctly less readable, while at the same time this descriptive material is placed just where it is most convenient for reference. Finally, there is a most excellent index.

Among the many things for which "Serindia" deserves particular approbation is the care taken in the transcriptions of Chinese names. Sir Thomas Wade's system, as exemplified in Gile's Dictionary, is that employed; and, while most students will probably agree that it is far from being an ideal one, it is at least the one best known and most generally used and therefore to that extent the standard, so far as writers in English are concerned. The way in which the transcriptions are accompanied by the corresponding Chinese characters is also deserving of notice and, in so far as possible, of emulation.

It would be difficult to point out any particular in which "Serindia" falls short of being all that a report of this kind should be. Sir Aurel presents the results of his labors in straightforward, succinct fashion, without weaving any theories or engaging in polemics of any sort. He has, furthermore, the happy gift, whether he is writing a personal narrative or compiling a formal scientific report, of knowing how to be vivid and interesting as well as painstaking and accurate.

C. W. Bishop

Ancient Cultural Relations Between China and Iran

Berthold Laufer. **Sino-Iranica: Chinese Contributions to the History of Civilization in Ancient Iran, with Special Reference to the History of Cultivated Plants and Products.** iv and pp. 185–630; indexes. *Field Museum of Nat. Hist. Publ. 201 (Anthropol. Ser., Vol. 15, No. 3).* Chicago, 1919.

As we all know, the success achieved by Dr. Laufer in the past two decades and more in throwing light upon Far Eastern culture development has placed him in the foremost rank among students in that field. His recent work, "Sino-Iranica," fully maintains the high standard of scholarship which he has set for himself, and for others as well, along those lines.

The object of the book, the author tells us (p. 207), is "to present . . . a synthetic and comprehensive picture of a great and unique plant-migration in the sense of a cultural movement, and simultaneously . . . to determine the Iranian stratum in the structure of Chinese civilization." In the pursuance of this aim no less than one hundred and thirty-five subjects are treated of. These are concerned mainly, as the subtitle informs us, with the diffusion of various cultivated plants. Such things, however, as Persian textiles and Iranian minerals, metals, and precious stones are also discussed; while a section is devoted to the titles employed by the Sassanian Government, and another to the cultural debt owed by the Persians to China.

In connection with his plant studies Dr. Laufer lays special emphasis upon the historical fact, so often ignored by later writers both native and foreign, that the great Chinese traveler, Chang K'ien, who first established a direct and conscious contact between his own land and western Asia, brought back with him two new plants and only two, viz., alfalfa and the vine (p. 190 and *passim*). The point is further made (pp. 220 ff.) that there can have been but one center for the origin of grape growing and that viticulture and wine making and the use of alfalfa as well were found by the Chinese among Aryan-speaking peoples and not at all among the Turks.

Another interesting and significant fact pointed out (p. 293) is that one of the fundamental differences between the Chinese and the Mediterranean civilizations was the use of hemp by

the former and of flax by the latter as the material for clothing. As Dr. Laufer says (p. 294), their failure to acquire flax in ancient times "is a clear index of the fact that the Chinese never were in direct contact with the Mediterranean culture-area, and that even such cultivated plants of this area as reached them were not transmitted from there directly, but solely through the medium of Iranians."

It is a trifle puzzling at first glance to see why the section on rice (pp. 372–373) should have been included, since it is unlikely that either of the two regions in question, China or Iran, received that food plant from the other. Nevertheless rice appears to have penetrated to Central Asian regions extremely early. The Chinese authorities cited on this point in "Sino-Iranica" carry us back to the second century B. C., while if the statement in the "Muh T'ien-tsŭ Chuen," or "Journeys of the Emperor Muh," can be believed, that ruler found a fine quality of rice growing in the west, apparently in the Tarim or Turfan regions, as far back as the tenth century B. C. Hence it seems not impossible that at least the easternmost of the Iranian-speaking peoples got their rice culture, some time during the prehistoric period, from the valley of the Hwang Ho instead of from that of the Indus or of the Euphrates.

It is interesting to note that Dr. Laufer now admits (p. 569) "some degree of probability in the old theory that the name 'China' should be traceable to that of the dynasty Ts'in." Those who have hitherto combated this hypothesis have done so mainly because they failed fully to grasp the importance of the rôle played by the principality of Ts'in (or Ch'in according to the more general pronunciation) long before her conquest of the rest of China late in the third century B.C. To say that "China" cannot be derived from "Ch'in" merely because the former name seems to have appeared in western lands in one form or another before the prince of Ch'in became emperor of China is wholly to overlook two cardinal facts: firstly, that from the eighth century B.C. onward Ch'in was in full control of the Central Asian gateway from China to the West; and secondly, that in the fourth century B.C. she also secured command of the Yünnan-India route by her conquest of eastern Szechwan and the upper Han valley. Thus it was wholly through Ch'in in those days, before the commencement of overseas intercourse between China and the West, that any knowledge of what we now call China proper could possibly reach the latter. Furthermore, in the fourth and third centuries B.C. Ch'in was one of the largest, most powerful, and best organized states not merely of eastern Asia but of the whole world. Hence it is not remarkable that the peoples of India, Persia, and lands farther to the west should have extended her name to the regions lying beyond her, whose products they received only through her and which she did actually in the latter half of the third century B.C. incorporate within her dominions.

Dr. Laufer rightly emphasizes (p. 186) the importance of the application of the laws of ancient Chinese phonology to the elucidation of Iranian tribal and place names and points out (p. 187) that the ancient Chinese scholars had developed "a rational method and a fixed system in reproducing words of foreign languages."

Undoubtedly well founded is the criticism of the prevalent system of transliterating Chinese words. Dr. Laufer might have said even more than he does in this regard; not only is it "clumsy and antiquated," but it is arbitrary and in many respects hopelessly incomprehensible to the lay reader without special instruction. Unfortunately it is too generally and firmly entrenched and represents too many vested interests to render likely its speedy replacement even by a system so consistent, so transparently simple, and so accurately phonetic, as that suggested on page 188. What is needed and what will be required before any real advance in this direction can be hoped for is a general and explicit agreement upon an improved system among students the world over. No man, even one of the standing in this field enjoyed by Dr. Laufer, can hope to do much singlehanded toward this end.

The primary usefulness of "Sino-Iranica" lies undoubtedly in the vast fund of information with which it provides us regarding a great variety of definite and specific Oriental culture objects and products. From this point of view it can scarcely be praised too highly. Yet it also performs another service, no less important because it is of a more general and less immediately striking kind. Most of us were taught at school that the Persian Empire was a vast, tyrannical, barbarian, "Asiatic" power whose function in the development of civilization was, like that of the Mongols or the Turks, destructive merely. Dr. Laufer, in this as in others of his writings, does much toward enabling us to correct such a view and to realize that in point of fact Persia in the days both of the

Achaemenides and of the Sassanians was a center of the world's very highest civilization, playing in the cultural development of all the lands about her a part whose importance we are only just beginning to understand.

C. W. BISHOP

POLITICAL AND SOCIAL IMPRESSIONS OF THE FAR EAST

J. O. P. BLAND. **China, Japan, and Korea.** x and 327 pp.; ills., index. Charles Scribner's Sons, New York, 1921. $5.00. 9 x 6 inches.

Mr. Bland's former residence and practical experience in the Far East and his wide official acquaintance entitle him to serious hearing. His book is divided into two parts, the first being a political survey and the second a series of chapters entitled "Studies and Impressions." The political and social life of the people of the Far East is in many respects closely interwoven with the physical circumstances of the region, a point of view which was developed in a scholarly and convincing manner in the January number of the *Geographical Review* ("The Geographical Factor in the Development of Chinese Civilization," by Carl Whiting Bishop, *Geogr. Rev.*, Vol. 12, 1922, pp. 19–41). We find ample evidence of this throughout Mr. Bland's book, particularly in the portions that deal with the density of population and the fine shades of adjustment which may be observed as the population, particularly of China and Japan, steadily increases, making the food supply a more intense question and bringing into play modern political and social forces of deep importance.

The second half of Mr. Bland's book is most delightfully written. He is never a dull writer, but in the later chapters the style rises to a very high level of literary perfection without at any time losing the quality of restraint that bespeaks judgment and integrity. In the field of political geography there are few contributions but rather the reaffirmation of points of view and of facts made familiar through western writings on oriental policies and practices during the past ten years.

One marked effect of the overcrowding of China, in the view of Mr. Bland, is the widespread desire to better living conditions; and this desire has steadily molded the character of the Chinese people through many centuries. Thus there is perpetual striving to raise one's self above the common level. Men of ambition seek power in order that they may gather to themselves forces and revenues that free them from the bondage of the soil or the shop and give them a standing comparable to that of the foreigner in the treaty ports. In Young China the author finds no saving grace, believing that the teachings of liberalism among the pupils of missionaries and colleges founded by foreign associations are quite superficial and that the blundering of the Tuchuns and the divisions of the past decade represent a constant force in Chinese life. To him there seems no way to escape but through a powerful government—if necessary a restoration of the Manchu Dynasty—and the holding of the great mass of the people and the local governors in a strong grasp. He believes that to let democracy come in is to open the door to disintegrating influences and bribery in a more extreme form than it has existed in China during the whole period of foreign domination.

The case of the crowded population in the homeland of Japan is argued skillfully and carefully, and an important and necessary distinction is drawn between two forms of expansion by Japan, one form being an actual movement of population overseas as a result of the crowding at home, and the other a kind of economic penetration which is equally efficient in relieving pressure because the flow of capital into a new region may control the labor of the region and its output of raw materials, thus fostering industry at home and providing additional support or better support for the crowding millions.

One is tempted to say of Mr. Bland's conclusions that he is too ruthless a logician. It can be almost demonstrated that every new cause is a failure—until it has achieved a state of pronounced success! A thousand visible and invisible forces fight a new idea. Moreover, the followers of the new (as well as the old) always include a large number of foolish persons and "optimists *de metier*," as Mr. Bland happily phrases it. We must recognize, however, that this is a changing world and that the force of new ideas cannot be measured in terms of old customs and characteristics. Finally, it may be said with assurance that it is not the masses of the people, to whom Mr. Bland refers political and social doctrines at every turn, that have ever controlled the fate of revolutionary changes. The mass of the people is inert, neutral, and lacking in initiative. In all lands and times

the great changes have been brought about by the will of a determined minority who have succeeded in the long run because their policies and ideas have been sound with respect to the tendencies of a whole people.

Geology and Geography of Central Celebes

E. C. Abendanon. **Voyages géologiques et géographiques à travers la Célèbes Centrale (1909-1910).** Vol. 1, xxvii and 443 pp.; diagrs., ills.; Vol. 2, xv and pp. 445–969; maps, diagrs., ills.; Vol. 3, xxii and pp. 971–1548; contributions of G. F. Dollfus, G. J. Hinde, J. H. Kruimel, S. J. Vermaes, and M. Weber, maps, ills.; Atlas, with the collaboration of J. J. Lefèvre, W. Schiebel, Raden Mas Amad, A. Raven, and W. F. Pandeij; sheets 1–12, 12B, 13–16. Publ. by the Royal Geographical Society of the Netherlands with the collaboration of the Ministry of the Colonies. E. J. Brill, Leyden, 1916–18. 11 x 8 inches. Atlas, 22 x 15 inches.

Of the numerous islands of the Malay Archipelago perhaps none is so interesting as the island of Celebes. Ever since the great English naturalist Alfred Russel Wallace made known to the scientific world more than sixty years ago the results of his observations, this island has been classical ground for the zoögeographer and naturalist. On the basis of his faunal studies he established what is known as the "Wallace line" which extends through the Strait of Macassar from north to south between Borneo and Celebes and which is supposed to be the dividing line between the Oriental and the Australian faunal regions. The controversy which followed this generalization had at least one beneficial effect in that it stimulated other naturalists to explore the island of Celebes more closely. The result is a vast amount of international literature bearing on this subject.

The establishment of the "Wallace line" involved the geological deduction that, during relatively recent geologic time, Celebes had belonged to the Australian continent, whereas Borneo had been part of the continent of Asia. But years elapsed before geologists participated in the discussion in the light of their own investigations on the ground. As a matter of fact, more or less systematic geological studies have been made only during the last twenty or perhaps thirty years. The names of Martin, Wichmann, Bücking, and the brothers Sarasin are worthy of mention as pioneers in this respect. During the last ten years, however, a change for the better has set in and, of late, very important geological work has been done by such men as Wanner, Ahlburg, Hirschi, Hotz, Gogarten, and especially by the Dutch mining engineer and geologist Abendanon. The results of his latest expedition, made in 1909–1910, have been published in the work under review, comprising three magnificent volumes with numerous text figures and beautiful plates, besides an atlas of maps and profiles.

The work deals particularly with the geology and geomorphology of the central part of the island; only scant and scattered reference is made to the response of human life to its particular environment as we now are wont to define geography. The first two volumes give a detailed description of the preparation for and the daily progress of the expedition which had as its main object a geologic and topographic reconnaissance of the region. The third volume summarizes the results achieved in their bearing on general problems. It includes reports from various specialists on the material collected on the trip, such as contributions on the paleontology by G. J. Hinde and G. F. Dollfus, on fresh-water molluscs by H. J. Kruimel, on fresh-water fishes by M. Weber, and on some phases of the economic geology by S J. Vermaes.

According to Abendanon the following elements, in addition to the coastal plains, can be recognized in the configuration of central Celebes:

1. A highly folded and faulted Pre-Cambrian gneiss-granite-schist complex in the central part.

All of it formed, during early Paleozoic time, part of a vast continent "Aequinoctia" (see E. C. Abendanon: Aequinoctia, an Old Paleozoic Continent, *Jour. of Geol.*, Vol. 27, 1919, pp. 562–578) and has since undergone submergence, upheaval, and peneplanation. Recent crustal movements have produced a network of *graben* and horsts. One of the major depressions is the Posso *graben*, some 75 kilometers long in a north to south direction, part of which is now occupied by a beautiful lake of that name. Another *graben* is the Fossa Sarasina—the Sarasin trough—to the west of the former. It is composed of a series of minor troughs in a north to south direction together about 100 kilometers long. Frequent earthquakes indicate that the crustal equilibrium in this part has not yet been established.

2. A coastal range to the west along the Strait of Macassar. As yet little more is known of this range beyond the fact that it is a folded chain of mountains of late Tertiary age.

3. An uplifted peneplain region to the east, the Verbeek Mountains, named after the Dutch geologist who has contributed so much to the geological investigation of the Dutch East Indies.

This region consists essentially of a peridotite batholith, at least 1,100 meters in thickness and of so vast an extent as to constitute, perhaps, the largest single occurrence of peridotite on record. This peridotite batholith of probable Mesozoic age is overlain, in places, by Pre-Tertiary sediments, 200–300 meters thick, part of which are highly folded.

The peridotite is nickel-bearing and may sometime become of great economic importance. The altered rock has given rise to extensive accumulations of lateritic iron ores similar to those found in Cuba but richer in iron and containing nickel in addition to smaller amounts of cobalt.

4. Several folded mountain ranges southwest of the central basal complex.

Some of these are composed of sedimentary deposits of Cretaceous and early Tertiary age; others are made up of various kinds of igneous rocks.

These ranges are separated from the mountains of southern Celebes by a depression running across the southern peninsula from the Gulf of Boni to the Strait of Macassar. This trough has become uplifted above sea level very recently, in Quaternary time; in fact, Abendanon has found evidence indicating that during the last fifty years the western part, at least, has been uplifted not less than five meters.

A short chapter treats of the peoples, who constitute three fairly distinct groups.

1. The coast people, who are Mohammedans and do not differ materially from the coastal people of other parts of the island. They are tradesmen and hardy navigators, but poor farmers.

2. The people of the mountainous regions, comprising different races known under the collective name of Toradjas. They are animists and live on the products of primitive agriculture and of the forests. They have developed arts and crafts to a relatively high degree. Aside from their passion for gambling they possess on the whole very desirable traits and have a capacity for higher development.

3. The primitive people of the dense forests, often heard of but not seen by the author except, perhaps, in a single instance.

A long chapter is devoted to the history of the cartography of the whole island of Celebes, from Ptolemy's time to the present, an exceedingly interesting review with numerous reproductions of historical maps as made by the earlier Portuguese and Dutch navigators.

The last chapter is given over to a short discussion of the origin of the word Celebes, which seems to have been derived from the native word "sellihe," equivalent to "current" or "stream," referring probably to the strong ocean current observed off the northeastern coast of the island.

M. W. SENSTIUS

EXPLORATION IN CENTRAL BORNEO

CARL LUMHOLTZ. **Through Central Borneo: An Account of Two Years' Travel in the Land of the Head-hunters Between the Years 1913 and 1917.** Vol. 1, xix and 242 pp.; ills.; Vol. 2, x and pp. 243–467; map, ills., index. Charles Scribner's Sons, New York, 1920. 9½ x 6½ inches.

Dr. Carl Lumholtz, author of these two volumes of travel in central Borneo, died at Saranac Lake, May 6, 1922, at the age of 71 years. He was a Norwegian explorer and anthropologist of international repute. His first expedition was made in 1880–1884 to Australia as zoölogical collector for the Museums of the University of Christiania. Among his mammalian discoveries on this expedition was the tree kangaroo of Australia. A narrative of the expedition was given in "Among Cannibals" (1889). In 1890–1891 he headed an anthropological expedition for the American Museum of Natural History and the American Geographical Society to the northern Sierra Madre Occidental, which was followed by other expeditions in the Mexican field described in "Unknown Mexico" (1902). An expedition in 1909–1910 resulted in "New Trails in Mexico" (1912).

In August, 1913, Dr. Lumholtz set out from Christiania with the intention of exploring the unknown interior of New Guinea on an expedition financed by the King and Queen

of Norway, the Norwegian Geographical Society, the Royal Geographical Societies of London and of the Netherlands, as well as by private contributions. After his arrival at Batavia a short excursion was made to northeastern Dutch Borneo to secure a Dyak crew for the work in New Guinea. The Kayan River was ascended, and advantage was taken of opportunities for observation on the country traversed and its people. The return to Batavia, where a military escort and other assistance was to have been furnished, was coincident with the outbreak of the war, in consequence of which the Governor General felt obliged to withdraw his support and urged Lumholtz to postpone his trip. Later, however, arrangements were made for a second and more extensive expedition to central Borneo in substitution for that originally planned. On the second expedition the Barito River was ascended from Bandjermassin, the capital, at its mouth; the divide was crossed, and descent was made by the Mahakam River. Another excursion was made up the Katingan River west of Bandjermassin.

The 1914 census returns for the South and Eastern Division of Dutch Borneo—about half the island—to which Lumholtz's travels were confined, give a total population of about 906,000 people, of whom only 800 are whites. Some 817,000 are Dyaks and Malays; 86,000 are Chinese, and the remainder Arabs and other aliens. Borneo has a remarkably even, mild climate with copious rain and is rather more healthful than most equatorial regions. The forests contain much valuable hardwood timber; the chief native sources of income, however, are still rubber, rattan, and bamboo. Wild fruits of many kinds grow to perfection. More than 550 species of birds have been noted. Of importance are the mineral resources; chief of which are coal (bituminous), gold, iron, diamonds, petroleum, tin, and antimony. Gold is everywhere but has not yet been found in sufficient quantities to make extensive mining profitable. The lack of development of native resources is due to the fact that the white population is so small and the means of transportation so insufficient. The petroleum industry has reached important proportions, and a commission was appointed in 1917 to study the gold and iron possibilities in the Schwaner Mountains. There is much opportunity for agricultural development in the alluvial country among the rivers, but the natives still employ the most primitive of methods.

Although the general anthropological classification has been that the Malays inhabit the coast and the Dyaks the interior, several distinct tribes have been identified, some aboriginal and others immigrant. Both the Dutch and the British, however, employ the Malay designation of Dyak for all the native tribes except the nomadic. The author gives a detailed description of the Punans, the nomads of the jungle. Except where Malay influence has overcome the native characteristics, the natives were found to be an honest, trustworthy people. Dr. Lumholtz devotes the larger part of his volumes to a description of their languages, customs, and religions. Nearly half of the second volume is given to native legends and folklore. The illustrations, with which the first volume is particularly well furnished, are chiefly of native types.

A Geographical Description of the Celebes

L. van Vuuren. **Het Gouvernement Celebes.** xxv and 535 pp.; maps, diagrs., ills., bibliogr., separate case of 23 maps. Encyclopaedisch Bureau, Vol. 1, 1920. Weltevreden, Batavia, Java. 11 x 8 inches.

The above volume, which appears to be only the first part of a compendious work, is particularly interesting as an indication of the earnestness with which Dutch East Indians are developing a knowledge of their superb possessions. The author is the chief director of the Encyclopedic Bureau by which the work is published. The volume now issued is devoted to a detailed geographical description of the island, largely in empirical form; beginning with the submarine slopes of the island (pp. 1–96), and continuing with its "horizontal form," particularly its coast. A great amount of authentic information is presented; but, physiographically considered, one must regret that the coast is treated in so great detail before the general form of the island, of which the coast is only a single contour line, is set forth. Many of the plates give good illustrations of coastal landscapes. A bibliography of 82 titles closes the volume.

W. M. Davis

A Comprehensive Work on Greenland

G. C. Amdrup and others, edits. **Grönland i Tohundredaaret for Hans Egedes Landing.** *Meddelelser om Grönland*, Vol. 60, 174 + 567 pp.; maps, diagrs., ills., bibliogr.; Vol. 61, 795 pp.; maps, diagrs., indexes. With accompanying atlas of 20 plates. C. A. Reitzel, Copenhagen, 1921. 30 kroner. 10¾ x 7 inches.

With the co-operation of a number of scientific men the Commission for the Geological and Geographical Survey of Greenland issued this comprehensive work in memory of the bicentennial of the disembarkation of Hans Egede in Greenland on July 3, 1721. It gives a systematic account of the country and of its development under Danish supremacy, principally on the basis of the wide and thorough researches during the last fifty years. The work is also meant to serve as a useful book of reference. These volumes are the result of the efforts of twenty-two editors and specialists and constitute a striking evidence of the co-operative ability of Danish scientific men. The volumes comprise a general synopsis, detailed descriptions of the different districts, biographical information, and a glossary with explanation of native names.

The general review gives a description of the natural conditions in the island and the surrounding seas—topography, geology, climate, glaciation, fauna, and flora. The Eskimos and their old culture—dress, houses, industries, tools, weapons, fishing gear, means of communication, social conditions, religion, etc.—are described.

On December 31, 1918, the total population of Greenland numbered 14,643, of whom 300 were Europeans. The distribution of the population in the different districts is given in detail in a number of tables. Other tables contain statistics of increase, distribution as to profession, birth and death, and causes of death.

Chapters are devoted to trade, fishing and hunting methods and results, business and communications, to administration, legal system, religion and education, sanitary conditions, language and literature, and scientific stations. The leading features of the history of Greenland from its discovery by Icelanders in the ninth century, together with the history of the scientific exploration of the island, are set forth.

The work is furnished with a number of good illustrations and is accompanied by an atlas with 20 maps, one of which is geological, most of them being topographical maps of the coast zone.

E. Antevs

Myths and Tales from Greenland

Knud Rasmussen. **Myter og Sagn fra Grönland.** 375 pp.; map, ills. Gyldendalske Boghandel, Nordisk Forlag, Copenhagen, Christiania, Berlin, London, 1921. 9½ x 6 inches.

Knud Rasmussen is peculiarly fitted by birth, training, and experience to work among the Eskimos, for they are, in a sense of which he is very proud, his own people. He is part Eskimo himself, his great-grandmother having been a South Greenland woman. His first education came from Greenland schools, and, though he later graduated from the University of Copenhagen, majoring in the Eskimo language, the fundamentals he learned in the little Greenland schools are still the basis of his knowledge. He speaks fluently the language and the dialect of every group along the Greenland coast.

For thirty years he has traveled the Greenland shores from Cape Farewell to the northernmost cape. He has visited every village and every group from Angmagsalik to Cape York. He has explored long reaches of unknown coast and traveled tens of thousands of miles by sledge and kayak with only Eskimo companions. He has lived their life, suffered their hardships and hazards, known their inmost thought, for thirty years. He has studied them as one of them.

In the complete collection of Eskimo tales and myths from Greenland which he presents in this book, he has gathered together the entire product of his long labors on the Greenland coast. From the Eskimos themselves he has gathered all this rich harvest of folklore and mythology and legend and tradition—sitting beside them in their igloos and writing down their tales by the light of their little blubber lamps; camping with them on their long hunts for caribou or bear or narwhal; sledding with them on far exploratory journeys; dancing and singing with them in the storehouses at the trading stations; always recording every new story, every significant observation.

The divisions of the book indicate the inclusiveness of the well organized matter: Eskimo Mythology; Conception of Nature; Animal Fables; Epic Tales; Meetings with Foreign Races; Curious Stories; Songs and Dialogues. Each division comprises several chapters.

The style is clear and forceful. Rasmussen indeed is no less an author than explorer and scientist, and as such he is well recognized among his countrymen. To anyone interested in the Eskimos, or the Far North, or the folklore of a passing race this book appeals with double charm; to the casual reader it is interesting, instructive, entertaining. An English rendition entitled "Eskimo Folk-Tales" (London, 1921) is reviewed in the July number of the *Geographical Journal*.

W. Elmer Ekblaw

Narrative of the Second Thule Expedition

Knud Rasmussen. **Greenland by the Polar Sea: The Story of the Thule Expedition from Melville Bay to Cape Morris Jesup.** Preface by Admiral Sir Lewis Beaumont. xxiii and 327 pp.; maps, ills., index. Frederick A. Stokes Co., New York, 1921. 10 x 8 inches.

While this English translation of Knud Rasmussen's most ambitious work does not entirely convey the fine spirit of the Danish original, it is nevertheless one of the most noteworthy contributions of this generation to the ever-fascinating field of Arctic exploration and the translators have succeeded in transferring faithfully Rasmussen's picture of the character of the Greenland coast, its scenery, life, and people. The subject matter of the original has for purposes of expediency been condensed and abbreviated, but nothing relevant to the purpose of the book has been omitted.

It will be recalled that the Second Thule Expedition, in reality Rasmussen's fourth Thule expedition, left Denmark in 1916 with primary purpose "to survey and chart the last unknown reach of Greenland's north coast between St. George Fiord and De Long Fiord." Its secondary objects were (1) to prove or disprove that migrations of the Eskimos take place around the northern end of Greenland from the west to the east coasts, long a mooted subject of discussion among the students of Eskimo dispersal; (2) to survey and map geologically the long extent of coast from Sherard Osborn Fiord to Peary Land, which was still blank on the geological map; (3) to keep meteorological records and to collect botanical and zoölogical material. The scientific results are stated in three appendixes (compare "Scientific Results of the Second Thule Expedition to Northern Greenland, 1916–1918," *Geogr. Rev.*, Vol. 8, 1919, pp. 180–187). The narrative is given in fifteen chapters which lead from the account of the Polar Eskimos, their land and life, the preparations for the long journey along the northwestern coast of Greenland and across the ice cap; through its arduous accomplishment to the homeward journey; and the losing race with death to save the life of the botanist, Dr. Thorild Wulff, the most trying and discouraging part of the trip. The chapter "A Runic Memorial" closes the volume fittingly.

The Second Thule Expedition was daring in plan and faithfully persistent in accomplishment. It is admirably recorded in "Greenland by the Polar Sea."

W. Elmer Ekblaw

An Expedition to Novaya Zemlya

Charles Bénard. **Un été chez les Samoyèdes (Juillet-Octobre 1914).** 4th edit. xii and 228 pp.; map, diagrs., ills. Plon-Nourrit & Co., Paris, 1921. 9 fr. 7½ x 5 inches.

In this volume Commandant Bénard, president of the Oceanographical Society of France, tells the story of a visit, cut short by the outbreak of war, to Novaya Zemlya, in 1914. His sojourn of two months and the account of it given here are the sequel of a former expedition (1908) of which a report was published under the title, "Dans l'océan glacial et en Nouvelle-Zemble" (1909). Some of the illustrations to the present volume appeared first in the other.

Commandant Bénard's plan of campaign in 1914 was to proceed to Novaya Zemlya by the Russian steamer which, once a year, in July, used to take provisions to the small Samoyed population of the southern island. Landing at Belusha Couba, near the western extremity of Kostin Strait, the passage which separates Mezhdusharski Island from the southwestern coast of Novaya Zemlya, he was to complete the map of the Strait, "at least

in a descriptive manner," cross Novaya Zemlya in the latitude of the Strait accompanied by a Samoyed with a sledge and a team of dogs, then make for a point, northeast of Goose Land, the peninsula which stretches north from Kostin Strait, by a different route from that followed by Chernyshev (1895). Finally, he was to return to Belusha Couba, crossing Goose Land from north to south. Failure to find dogs enough and a Samoyed willing to accompany him at Belusha Couba resulted in a modification of his plans. He carried out a brief reconnaissance of the Strait in a whaleboat, made a dash on foot and alone across the main island, and returned to Belusha Couba, where he eventually managed to persuade one of the Samoyeds to build for him a light sledge, provide a team of dogs, and accompany him across Goose Land on foot, using the sledge for the conveyance of a tent, surveying apparatus, and provisions.

The principal results of M. Bénard's expedition were to establish the fact that Goose Land is a low-lying plain, innocent of the mountains which have hitherto figured on the map "in fantastic fashion," to add three fiords to the coast line of Kostin Strait, and to ascertain the direction—north and south—of the chains of rugged hills which flank Goose Land on the east, parallel with the chain of the central divide. There is an interesting account and explanation of the nature and the disintegrating effect on the surface of the southern island of the peculiar *bouffettes*, a sort of pustule, as it were, of mud which crop up everywhere among the fractured schists of which the land is principally composed.

The corrections of the existing maps are made almost entirely "in a descriptive manner." There is one small sketch map in the book. It contains no indications of the relief. Few of the places named in the text are marked on the map. A short chapter only, in spite of the title of the book, is devoted to observations on the life and manners of the Samoyeds of the regions visited.

With the limitations indicated, M. Bénard's volume is a welcome contribution to the rather scanty geographical literature of the region. There is a useful discussion of the routes through the Barents and Kara Seas, as conditioned by the prevailing winds, the direction of the currents, and the ice.

H. U. Hall

A Regional Geography of France

Emmanuel de Martonne. **Les régions géographiques de la France.** 190 pp.; maps, diagrs., bibliogr. (Bibliothèque de Culture générale.) Ernest Flammarion, Paris, 1921. 4 frs. 50. 7½ x 4½ inches.

France has been the subject of more valuable regional studies than any other country, thanks to the influence of the late Paul Vidal de la Blache, who himself composed the model in his "Tableau." Some of his pupils, as is well known, have applied his method in their studies of a number of the separate regions of France, all of which form admirable treatises. And now one of them, Professor de Martonne, has presented the geography of almost the whole country in an original form and, in doing so, has achieved remarkable success. The publication of this work is of special interest to Americans because it has developed from a series of lectures delivered by M. de Martonne first at Columbia University and later at the Sorbonne, where they were specially designed for foreign students. It is significant that this book, which is real geography from start to finish, finds a place in a "Library of General Culture," to which indeed it is admirably suited. The author has striven—and one may hope has succeeded—to depict and explain "to any cultivated and curious mind" the varied aspect and resources of the soil of France; and the method he has chosen for thus arousing the interest of the general reader could scarcely be bettered.

The author plunges *in medias res* with a description of Paris—its position, site, growth advantages and disadvantages—in the first chapter and follows with successive chapters on the Paris region and basin, Picardy and the Champagne, Lorraine, the Vosges and Alsace, and so on over the most of France. It may be surmised that the reader will thus gain an appreciation of the meaning of geography and will be prepared to fill out the gaps from other sources. This book alone leads to an intelligent appreciation of the varied landscapes of France and of the intimate and manifold associations of land and people in the different contrasted regions; but it gives the reader no idea of the geography of France as a unit. We are left with the feeling that a chapter is lacking which would pull the regions together and sketch the homeland of the French people in lines as decisive and

impressionistic as those which outline so satisfactorily each of the component parts. Such a chapter, it would appear, the author might well have worked in to the advantage of this otherwise excellent book without attempting to make it a complete geography of France with full treatment of distributions, physical and human, which can quite well be sought for in other books and atlases. Illustration is limited to a few block diagrams, and it is essential that a good atlas be before the reader; and where possible the maps of the Service Géographique de l'Armée—either on 1 : 600,000 or 1 : 200,000—should be consulted.

Having noted these omissions we may characterize M. de Martonne's work by stating that we know of no more concise and telling geographical description at once vivid and explanatory which has so successfully encompassed a territory of the area and variety of France within 190 short pages. Not a word is superfluous, and the style is easy and attractive. With his reputation as a physical geographer the author could be counted on to provide lucid accounts of the various land forms and their origin. These are present but not overweighted, and they are deftly worked into landscape description in such a way that man is the central figure. Nowhere is local patriotism stronger than in France; and in no civilized country is man more directly dependent upon the soil. France excels, then, as a field for the study of the relationships between man and his habitat, and we are grateful to Professor de Martonne for presenting a great subject in simple language.

The Rocky Mountain Trench

S. J. Schofield. **The Origin of the Rocky Mountain Trench, B. C.** Maps, diagrs. *Proc. and Trans. Royal Soc. of Canada*, Ser. 3, Vol. 14, 1920, Section IV, pp. 61–97.

F. P. Shepard. **The Structural Relation of the Purcell Range and the Rocky Mountains of Canada.** Maps, diagrs. *Journ. of Geol.*, Vol. 30, 1922, No. 2, pp. 130–139.

Because the Rocky Mountain trench is the "most remarkable structural feature of the Canadian Cordillera" any addition to our knowledge of it is of wide geographical interest. The trench forms the western boundary of the Rocky Mountains of Canada practically throughout its whole length for a distance of over 800 miles. Its direction is almost constant north 33° west. In it are the headwaters of nine considerable streams. The sides of the trench rise on an average 4,500 feet above the valley floor; the width averages 4 to 6 miles; the floor is flat or slightly rolling; and, finally, glaciation has smoothed and trimmed its interlocking spurs to such an extent as to increase its linear quality and give it its modern trough-like characteristics.

Of particular interest in physiography are the series of cross sections on page 74 of Schofield's paper and the accompanying discussion of evidences of faulting. Schofield, following Daly, considers that the origin of the trench in an almost continuous zone of faulting is now well established. It is his belief that sharp changes in rock character in short distances at a few localities where actual faults have been observed and other pronounced structural features from which faulting is clearly inferred furnish a strong basis for a definite conclusion on this question. The normal faulting in evidence probably took place in Eocene time. It produced not only a depression but also a zone of shearing along which rivers would tend to erode rapidly. The author discusses at some length the effects of erosion in Cretaceous time and the reduction of the highlands to a peneplain. In this fact and in subsequent broad crustal movements, coupled with the structural features of the Rocky Mountain trench, we have an explanation of the drainage relations of today. These relations are traced out in considerable detail; but the history of Pleistocene and recent drainage in British Columbia is not discussed, the reader being referred to Dawson's famous paper read before the Royal Society of Canada in 1889.

Shepard takes issue with Schofield and Daly with respect to the explanation outlined above. From a study of 180 miles of the Rocky Mountain trench between Gateway, Mont., and Golden, B. C., he concludes that it is not a unit in development and structure but that its different parts have had different origins—"partly by normal erosion, partly by erosion along lines of structural weakness, and partly by the escarpment of a fault (*sic*)." The faulting adjudged to be operative was of the thrust rather than of the normal type. It was a zone of weakness at the present locus of the trench in the Purcell Mountain region, caused by the intersection of a large number of fault planes, that hastened the erosive processes.

In the central section of the stretch studied by Shepard (Canal Flats to Bull River) there appears to be no relation between the trend of the trench and the structural lines. From this fact and the great width of this part of the trench, greater age is inferred, such as would be associated with a peneplaned surface where drainage had freed itself from the bondage of earlier structural and topographic controls.

Drift of the Earth's Crust and Displacement of the Pole

Alfred Wegener. **Die Entstehung der Kontinente und Ozeane.** 2nd edit. viii and 135 pp.; maps, diagrs., index. *Die Wissenschaft: Sammlung von Einzeldarstellungen aus den Gebieten der Naturwissenschaft und der Technik No. 66.* Friedr. Vieweg & Son, Brunswick, 1920.

Wladimir Köppen. **Polwanderungen, Verschiebungen der Kontinente und Klimageschichte.** Maps, diagrs. *Petermanns Mitt.*, Vol. 67, 1921, January-February, pp. 1–8; March, pp. 57–63.

Wladimir Köppen. **Ursachen und Wirkungen der Kontinentenverschiebungen** und **Polwanderungen.** Diagrs. *Petermanns Mitt.*, Vol. 67, 1921, July–August, pp. 145–149; September, pp. 191–194.

The authors are meteorologists stationed at the Marine Observatory at Hamburg; they have apparently worked more or less in conjunction and cover very much the same ground in their publications. Wegener is more detailed in his description of the displacements of the continents; Köppen, of the changes of the earth's axis of rotation. The picture they present of the history of the earth's crust is as follows. The material of the upper 1,500 kilometers of the earth's crust is of two kinds, Suess' *sima* (rock rich in magnesium) and *sial* (rich in aluminium), Suess' *sal*. The latter is less dense than the former, is very much less in amount, and floats in it as icebergs float in water. The authors draw confirmation of this idea from the hypsometric curve, and Wegener gives a rather striking diagram of the relative areas at different levels of the lithosphere, showing the preponderance of a continental and an oceanic plateau, as first described by Murray. The sima is highly viscous and reacts as a solid to temporary forces but yields to long-continued forces. The sial is much more rigid and, though capable of being folded, is more apt to fracture. At the beginning of geological time, the sima layer was entirely covered by a mantle of sial about 30 kilometers thick. For some reason not given, this broke up and the sial collected together in a single mass (with some gaps), about 100 kilometers thick, to form the continents. Then the process was reversed, and one part after another broke away and floated off, with the result finally of the present distribution of the continents. By selecting the times of the various disruptions, by assuming great changes in the position of the earth's poles, and by introducing other hypotheses where needed the authors attempt to account for the variations in geological climates, for the distribution of former and recent fauna and flora, for glaciation and for many mountain chains. During Carboniferous and Permian times the disruption had scarcely started: the American continents were in contact with Europe and Africa; the latter, Antarctica, Australia, and India (which then stretched far to the south) were continuous; and the south pole of the earth lay in southern Africa. The existence of a common Permian glaciation in these countries is thus accounted for, for the authors think that strong glaciation is due to nearness to a pole lying in a land area. They overlook the evidence of glaciation in the mid-Carboniferous in Oklahoma and in the Permian in Massachusetts, England, and Germany—regions which were then quite close to their equator. Some similarities in the geological fauna and flora of the southern areas are also explained by their juxtaposition. The two parts of the Hercynian mountain range of the eastern and western hemispheres were united, as the north Atlantic ocean had not yet been formed. In the Eocene, things began to happen. Taking Africa as our point of reference, we may consider it at rest; Australia broke away and moved off to the east; Antarctica slipped off to the south; India to the northeast, crumpling up the mass in front of it to form the Himalayas; South America began to pull away from South Africa; but it was not until the Quaternary that northeastern North America, Greenland, and northwestern Europe were torn apart. Hence the distribution of glaciation during the Pleistocene ice age in the two continents, for, at that time, the north pole is supposed to have been in the present north Atlantic and about 20° from its present position.

Wegener is quite right in saying that in reconstructing the geography before the folding of a mountain range the greater area required by the smoothing out of the folds should be considered, a point not sufficiently taken into account by paleogeographers; but he is wrong in supposing that the Himalayas were folded in the Tertiary; they were elevated in this period, but the folding was earlier.

The continents being formed of light sial stood higher than the ocean basins, which consisted of sima. Therefore the centrifugal force due to the earth's rotation would tend to move them towards the equator. We find no calculations to show the competency of this force, but it is quite certain, according to the map drawn by Wegener, that the continents never did cluster about the equator. On the contrary, their general drift is supposed to have been westward. It is suggested that this westward drift may be due to the same cause as the westward direction of the trade winds, namely, the influence of the rotating earth on matter approaching the equator. But the authors do not claim that the American continents have shown any definite movement toward the equator; so the suggested explanation of the westward drift is inapplicable.

Wegener finds confirmation of the western drift of Greenland in the determinations of longitude made there in 1823, 1870, and 1907 by Sabine, Payer, and Koch respectively. They apparently show a westward movement of Greenland averaging 9 meters a year during the first interval and 32 during the second. The observations were made on the east coast of Greenland in latitude about 75° N., and the changes of longitude found seem to be outside the errors of observation. Foldings of the strata and the great overthrust faults teach us that parts of the lithosphere do move horizontally, and we have definite measures of movements along the western coast of the United States and in the island of Sumatra. If the movement of this part of Greenland should be confirmed, it would naturally be classed with those mentioned; but it would not indicate a general westward drift of the Americas. A movement of 32 meters a year is of the order of movement of the ice of moderately large Alpine glaciers; it is 500 times as large as the measured movement on the Pacific coast.

The resistance the sima of the ocean bed of the Pacific Ocean offered to the western drift caused a folding and crumpling up of the western border of the Americas, forming the Andes and the western mountains of North America. The same objection applies to this case as to the Himalayas; the folding occurred earlier. The great deeps along the South American coast are supposed to be due to the sinking of the sima to allow the lighter sial to pass over it. Experience indicates that the pressure of a moving mass would cause an elevation of a viscous substance in front of it. Where mountain ranges are formed away from the front of a moving continent, such as those of central Asia, they are supposed to be due to variations in the friction in the sima below. The ocean bottom is supposed to be smooth and featureless—an old idea, which modern soundings do not confirm. It is supposed to be free from foldings; of this we are entirely ignorant. The group of festooned islands off the eastern coast of Asia, together with the Antilles, are supposed to have been broken off and held back by special friction from the westward-drifting continents. The Atlantic islands are supposed to be carried off from Africa by special currents in the sima. The mid-Atlantic ridge is supposed to be formed by deposits when only a narrow strait had been formed between Africa and South America; but the ridge is far from either continent. The elasticity of the hypothesis is evident.

The authors accept the principle of isostasy, as indeed their general hypothesis requires; but they do not hesitate to assume lack of isostatic adjustment where it is indicated by their hypothesis. As we have not properly reduced gravity measures in these regions, the matter cannot be tested. When mountain ranges are formed by compression the lighter sial is forced down as well as up to satisfy isostasy. This is Osmond Fisher's idea, based on Airy's paper of 1855. The objection to it is that, at any rate many mountain ranges were elevated long after they were folded (see a paper on "Isostasy and Earth Movements," *Bull. Geol. Soc. of Amer.*, Vol. 33, 1922, pp. 317–326).

The explanation of the geologic climates by the displacement of the pole has been a favorite speculation of many geologists; and our authors use it to the full. The distance between the positions of the pole in the Carboniferous and in the Pleistocene would, according to them, be about 65°; but the length of the path followed from the former time to the present would be three times as much. There are difficulties in the way of such assumptions. It is curious that Köppen thinks that justice requires him to mention an obscure work, full of inaccuracies, whereas neither author mentions the classical paper

of George H. Darwin, "On the Influence of Geological Changes on the Earth's Axis of Rotation" (*Proc. Royal Soc.*, Vol. 25, 1876–77, pp. 328–332). Köppen reports at length a paper by G. V. Schiaparelli (1889), which, so far as I can judge from his account, is merely an elaboration of a part of Darwin's work. His argument is this, that though the axis of rotation of a rigid earth could not depart more than a few degrees from its axis of figure, as a result of any possible geological changes, the axis of a plastic earth could be changed indefinitely under a continuing cause. You will find that in Darwin. But where is the cause? It is easy to see from Darwin's calculations that if the North American continent were floated off from Europe to a distance of 90° to the west, the displacement of the pole would be only a few minutes of arc; which would, moreover, be partially counteracted by the simultaneous drift of South America. Such changes cannot occur repeatedly. What geological changes can be imagined that will continue to move the pole *in the same direction* through 65°? Our authors suggest none.

The hypothesis of the movements of the pole and the drift of the continents was adopted to fit certain facts, such as the reciprocal outlines of South America and Africa, the principal location of Permian glaciation, etc.; but, as has been shown, it does not fit other facts. As a further instance, the position of the north pole in Eocene time was placed about as far from Alaska as it now is, but on the other side. We should therefore expect a cold climate in Alaska during the Eocene; but this is just the time that the climate there was warmest, as far as we know. Our authors rely on many of the older estimates of geological temperatures, which require modifications in the light of later studies.

There have been many attempts to deduce the characteristics of the earth from a hypothesis; but they have all failed. There is the pentagonal system of Élie de Beaumont, the tetradedral system of Green; and others might be mentioned. This is another of the same type. Science has developed by the painstaking comparison of observations and, through close induction, by taking one short step backwards to their cause; not by first guessing at the cause and then deducing the phenomena.

HARRY FIELDING REID

WALL ATLAS OF COMMERCIAL GEOGRAPHY

GEORGE PHILIP. **Philips' Comparative Wall Atlas of Commercial Development.** A set of eight maps, size 42 by 34 inches: (1) World, 1: 40,000,000; (2) Europe, 1: 6,000,000; (3) Asia, 1: 12,000,000; (4) Africa, 1: 9,000,000; (5) North America, 1: 9,000,000; (6) South America, 1: 9,000,000; (7) Australasia, 1: 6,000,000; (8) British Isles, 1: 1,000,000. George Philip & Son, Ltd., London, [1922.] 3s. 6d. each, unmounted.

Geography as an interpretative science is greatly indebted to the house of Philip. They gave us a few years ago an invaluable set of maps, the "Comparative Wall Atlas." In this set, for instance, the map of natural vegetation went beyond the miserable confusing designation that had been used so disappointingly before under the title of "woodland, grass, and cultivation." These maps are real geography in a visible, quickly understandable, and highly effective form.

The announcement of a new series was greatly anticipated by the reviewer, but he must confess to considerable disappointment. The purpose and method of construction of the present series of maps of commercial development were described and exhibited before the Royal Geographical Society some years ago (George Philip: A New Series of Economic Maps for School Use, *Geogr. Journ.*, Vol. 50, 1917, pp. 438–447). Mr. Philip then said: "How, then, within the limits imposed by the size to which a school atlas is restricted, and the number of maps which it can afford to devote to economic geography, can we prepare a really useful series of economic maps? After experimenting on various lines, I decided that the right method to adopt was to associate the distribution of the population with the nature of its economic activities. This conclusion meant in effect that the groundwork of the economic map should be formed by the combination of a map showing the density or distribution of the population and a map showing regional vegetation. Only by weaving together the materials supplied by these two maps did it seem possible to obtain the basis for a reliable representation of the progress achieved by man in his exploitation of the world and its resources, and of the general character of his various occupations."

The new series has appeared in the form of wall maps, but it may very properly be called an atlas also. One must walk up close to the maps to see what is on them. Some useful information of this sort is the table printed on a white patch in the blue ocean near each port showing its total exports and imports and several of the leading articles of both import and export arranged in order of importance. The maps are mines of information to be painfully studied at close range. The process indeed is painful because of the confusion that arises largely from the working out of the fundamental idea of "weaving together" the data of population distribution and vegetation. Thus one color is given for land (agricultural, pastoral, and forest) with one population density, and an entirely different color for the same sort of land with a different population density. The result of this is that the forests of Sweden and the almost grassless and quite treeless steppes east of the Volga appear in the same color. For undeveloped parts of the world some of the maps are much better; for example, regions of different kind of forest in Labrador, Canada, and Alaska are shown with great minuteness; the areas of virgin tropical forest come out quite clearly where there is no agriculture to confuse.

The sense of confusion is increased by the use of colors that vary from each other so little that the ordinary person has difficulty in carrying the distinction from the legend of the map. This seems almost inexcusable when one considers that the maps are quite likely to fade somewhat and, in the second place, that for years it has been customary to use a small figure to carry identification in cases of this sort. The world map of occupations is better than the continent maps because the attempt to weave together two different things has been abandoned; but here we still face the difficulty of color identification.

The makers of the series have fortunately taken the advice of the British Association and avoided the hopeless business of trying to show economic phenomena by writing words or letters on the maps. They have adopted instead seven or eight symbols in red to show iron, copper, tin, diamonds, gold, coal fields, petroleum. One of the interesting results of this method is to show on North America by the red hollow squares iron in eastern Tennessee, on the Virginia-Carolina boundary not far from Norfolk, at Butte, Mont., at Madison, Wis., but none at Chicago, Pittsburgh, or Buffalo.

The question of accuracy or up-to-dateness of information is brought slightly into question when one sees the designation "Regions Incapable of Development" (desert, tundra, Alpine, etc.) and observes that it is made to cover four-fifths of Alaska and those parts of Canada where Stefansson has described herds of caribou so large that they covered acres or even square miles and took days to pass, with total numbers which ran into the millions. Indeed these caribou herds are beyond doubt the greatest masses of meat animals to be found anywhere on the earth today.

The maps show at a glance by the size of the band in the ocean the value of commerce for certain routes, and here they are entirely different from all previous maps of this sort, which indicates that either the other maps are wrong or that this one is using war valuations; but there is no date to make us certain about this.

In the corner of the world map is an inset showing the means of communication, including beasts of burden; and ice-closed seas are also indicated—a valuable addition here and on the continent maps where it figures.

As it is, the reviewer expects to go back to Philip's earlier series and have his students use it in conjunction with Finch and Baker's "Atlas of World Agriculture" and the U. S. Geological Survey's "Atlas of Mineral Resources." If Messrs. Philip would simplify the maps of Commercial Development to some extent, he would probably wish to use them; but these good workers have fallen prey to the very natural impulse to overload that greatest of all printed pages, the map.

J. Russell Smith

Two British Textbooks of Geography

R. N. Rudmose Brown. **The Principles of Economic Geography.** xv and 208 pp.; bibliogr., index. Sir Isaac Pitman & Sons, Ltd., London, Melbourne, Toronto, New York, 1920. 8½ x 5½ inches.

O. J. R. Howarth. **A Commercial Geography of the World.** 2nd edit. 235 pp.; maps, diagrs., index. (The Oxford Geographies.) Clarendon Press, Oxford, 1920. $1.80. 7½ x 5 inches.

"Principles of Economic Geography" is a book of two hundred and eight pages, eighty thousand words, without a map, picture, graph, or diagram. It tries to cover everything

including self-determination, molybdenum, rocks, soils, and climate. Divisions of space are interesting: corn (maize)—1 page; pigs—16 lines; molybdenum—10 lines; nitrates—11 lines; causes of emigration—20 lines; Northeast and Northwest Passages—1 page (39 lines); slave trade—3½ pages.

Furthermore, there are many mistakes in statements of fact. "Brazil overshadows all other countries in annual output" [of rubber] (p. 50). The book was copyrighted in 1920, two years after the collapse in the rubber price resulting from the enormous cultivations in the Orient which had far surpassed poor Brazil in amount. The author's knowledge of rubber appears to be botanic, encyclopedic, about ten years behind the time, and with no economic flavor worth mentioning. Turning over a page one sees that Egypt produced in the year 1918–1919 4,800,000 bales (of 400 lbs.) of cotton. The United States Department of Agriculture puts it at 1,304,000 bales (of 478 lbs. net) in 1918; 999,000 in 1919.

I believe in a liberal forgiveness for mistakes, but the above-mentioned are egregious. So is this: "Warm currents wash the western coasts (in temperate regions), and the prevailing winds are from the south and west." Most of the children's geographies in America have a special designation to show that the currents along the western coasts of South America and Africa and California are *cold* or *cool*. I wonder how the author would prove his statement that "Slavery in Africa, or even in Mediterranean Europe, was a kindly bondage compared to what the black man had to face in America." What is Africa's record of slavery?

In some places the book does come up to definition and discuss *principles*, which I believe are *ideas;* but some of the discussion is of political geography, and most of it is merely another case of the statements of fact without cause or result so common on the other side in books which Mr. Cundall recently called, very properly, "mere cramming implements."

Perhaps much of the trouble is indicated by the author's remarkable statement in the introduction. In discussing the scope of economic geography and its relation to various other sciences he says, "An adequate knowledge of the tributary sciences is helpful but not essential to the geographer." I want to emphasize the opposite idea most emphatically. One of the chief handicaps of geography at this moment is that it has so *few* men adequately trained in tributary sciences. I hope we do not have to await the creation of these men before we have a real "Principles of Economic Geography."

Howarth's little book of 234 small pages, about 55,000 words, is smaller than Rudmose Brown's; other than this it offers great contrast. It is *full of geography*, splendidly illustrated, with 33 inexpensive black-and-white maps that carry points very effectively. One of these is a map of southeastern Asia showing rice regions by dots and heavy population by heavy vertical rulings, indicating striking similarity in location of the two factors.

The chapter titles show the plan. They are: General Considerations, Cold Regions, Temperate Lands, Temperate Lands (*cont.*), Hot Lands, Fisheries, Mining and Manufactures, Transport, Trading Centers, Grain Trade, British Isles, Scandinavia and Russia, Central Europe, European Mediterranean and Balkans, North America, Temperate Lands in Southern Hemisphere, The Monsoonal and Other Asiatic Territories, The Hot Lands in Africa and America, and the Pacific Islands.

The book starts by reproducing Herbertson's well-known Natural Regions Map. The first half of the book, which shows much thought, continually ties back to this piece of fundamental geography. The latter part of the work is less geographic and more encyclopedic—often mere statements that this or that is here or there.

J. Russell Smith

Some Meteorological Books

George A. Clarke. **Clouds: A Descriptive Illustrated Guide-Book to the Observation and Classification of Clouds.** With a Preface by Sir Napier Shaw. xvi and 136 pp.; maps, diagrs., ills., index. E. P. Dutton & Co., New York. $8.00. 8½ x 5½ inches.

A. E. M. Geddes. **Meteorology: An Introductory Treatise.** xx and 390 pp.; maps, diagrs., ills., index. Blackie & Son, Ltd., London, Glasgow, and Bombay, 1921. 21 s. 9 x 6 inches.

R. G. K. Lempfert. **Meteorology.** x and 186 pp.; maps, diagrs., ills., index. Methuen & Co., Ltd., London, 1920. 7s., 6d. 7½ x 5 inches.

Mr. Clarke's book on clouds is well described in the subtitle: he has contributed a unique collection of photographs, the faithful effort of many years; and the publishers have done their part equally well. There are four color plates—all unique and excellent though per-

haps a trifle vivid, seventy-two photographs, and seventeen diagrams and figures. No one who admires skyscapes should be without this book; for it gives with well chosen illustrations and in carefully written text about all that one ordinarily wishes to know about clouds.

While recognizing that it needs overhauling, Mr. Clarke accepts the International Classification of the clouds, which embraces five general divisions and ten types. There are types, however, which lie outside this scheme; and these, like the mammato-cumulus, the lenticularis, and the turret clouds, are listed separately.

A rather brief account of cloud velocities is given, and it is evident that it is not the practice at British meteorological stations to get actual velocities. A Fineman nephoscope is employed, and only angular velocities are recorded. If these are reduced, using average values for the types of cloud as given in the International Classification, the average actual velocities are: cirrus, 60 miles per hour; cirro-stratus, 60; cirro-cumulus, 45; alto-cumulus, 30; alto-stratus, 35; strato-cumulus, 22; cumulo-nimbus (central mass), 35; and cumulus, 31. Mr. Clarke adds that some of the individual velocities for cirrus are very high; for, assuming the cloud to have been only 23,000 feet instead of the 30,000 feet given as the average, the velocities not infrequently reached 100 or 130 miles per hour. Our author may feel justified now in using the higher value, for by direct measurement at Blue Hill Observatory, a cirrus cloud has been recorded traveling at the rate of 102.6 meters per second, that is 228 miles per hour. There are supporting records on various dates of 94 meters per second (210 miles per hour) and 84 meters per second (188 miles per hour). Velocities of 60 meters per second, or 130 miles per hour, are not infrequent.

Four striking photographs of the upper surfaces of cumuli and strato-cumuli made in an airplane (old style aeroplane) by Captain C. K. M. Douglas, are added to the sixty-eight cloud photographs of Mr. Clarke. These were made at heights of 3,000 meters.

It is a little singular that there is no reference to Clayton's first-class work at Blue Hill and only a reference at second hand to Bigelow's extensive report. We might mention too, that no details concerning the photographic methods employed are given. It is all very well to show beautiful photographs; but in a book of this character a few words of advice and instruction to those who would like to try their prentice hand "catching the clouds" would be much appreciated.

Dr. Geddes, a lecturer in natural philosophy in the University of Aberdeen, who adds to classroom experience knowledge gained during the war in the Meteorological Section of the Royal Engineers, has given us an unusually lucid and well written textbook. Recognizing that there are others in the world besides undergraduates, he writes for aviator, farmer, sailor, and even the holiday-maker. The lengthy introduction contains a strong plea for an educated public; for something more than Weather Bureau or even a Meteorological Society; and we agree that this is necessary if weather observations and forecasts are to be understood and utilized to full advantage. Dr. Geddes is right in saying "There is perhaps no other subject which attracts the attention of so many people, yet perhaps there is no other subject about which so many false ideas exist."

The succeeding chapters deal with the Atmosphere, Radiation, Temperature, Pressure and the General Circulation, Water Vapor, the Minor Circulations, the Free Atmosphere, Atmospheric Electricity, Atmospheric Optics, Atmospheric Acoustics, and Weather Forecasting and Climate.

Dr. Geddes is a physicist and so clearly recognizes the value of employing scientific units. For temperature, he says, referring to the absolute Centigrade scale, "this scale is the only scale on which there is a definitely fixed temperature, the absolute zero of temperature." He is evidently not aware of the Kelvin-kilograde scale. He says, "I have employed the gas scale [the absolute Centigrade] throughout." But the types have played him false, for Figures 1 and 2, thermograph records August 1 and August 3, 1919, at Aberdeen, are in degrees Fahrenheit, without even equivalent values. The time scale, however, shows that the Aberdonians (and this is generally true of British observers) are ahead of Americans, for the hour which we call 11 P. M. they call 23.

The book is one which the professional meteorologist will find convenient for reference, and the layman will find not only readable but stimulating.

In "Meteorology" Mr. Lempfert has endeavored to present in simple speech, and we may add in attractive dress, the chief results derived from modern methods of air exploration. In fact, he brings up to date Dickson's volume on "Meteorology" which appeared in the University Extension Series about 1893. The observational side is subordinated to dynamical studies; and climatological data and descriptions of instruments have been omitted.

As Superintendent of the Forecast Division of the British Meteorological Office, Mr. Lempfert is well qualified to set forth the possibilities—and limitations—of the synoptic map, on which, as we all know, official forecasters rely.

The Weather Map is explained in detail, and the somewhat astonishing statement is made that "despite the fact that maps have now been drawn day by day for over half a century, we may safely say that no two maps have been identical." For that matter, no two snow crystals are identical; but they can be classified and grouped; and so can weather maps. This should have been added.

Mr. Lempfert writes in an easy and familiar way of the work of the forecasters during the Great War. The book begins with a study of a certain anticyclone which persisted from September 5 to 14, 1915. Probably because the author is a forecaster he realizes what most writers of meteorological books have failed to comprehend, namely, that the anticyclone is the dominating factor in determining weather sequences. Apparently it controls the path and speed of the "lows" following it.

There are different types of "highs," and, unfortunately, the Weather Map gives little indication of such difference. There are cloudless anticyclones and clouded anticyclones if the latter word may be allowed. In the cloudless type in summer, high temperatures prevail; and, as the condition is one of stagnation, there is an accumulation of heat in the lower levels and so a hot spell lasting several days—a period when the forecaster can promise no relief. In the same type during winter, because of free radiation, extremely low temperature may occur. In the other type of "high" the temperature amplitudes are limited, and conditions are more uniform. At such times surface readings of pressure and temperature may mislead the forecaster.

A good illustration of a "cyclone," "depression," or "low" is that of February 17, 1915; and the discussion loses nothing of interest when the author drives home the fact that two German airships were wrecked on the coast of Denmark through stress of weather. This happened, our author states plainly, because the German forecasters were unable to locate the center of the depression—which was over Ireland. With commendable frankness, however, he states that British forecasters, lacking definite information, would have been unable to do any better than their German colleagues. The reviewer, who happens to have had some experience in Europe during the war in connection with forecasting, ventures the opinion that if the matter could be investigated closely it would appear that delay in transmission of weather reports hampered the forecasters, for even in France it was no unusual thing to receive morning reports late in the afternoon.

The map for October 19, 1917, the date of the great Zeppelin raid, is given and is a good example of an anticyclonic wedge. An unexpected strong current from the north carried the air fleet (13 in number) out of course, on the return, and led ultimately to the loss of 8 airships—the flower of Germany's air fleet.

The chapters on Temperature and Clouds are brief but to the point. Only eight illustrations of cloud types are given. On page 47 the place of the highest sounding balloon record is given as Padua. We understand the record was made at Pavia.

In the chapter on the Stratosphere, on page 144, it is stated that the lowest recorded temperature "at ground level is 213a, observed on the great ice barrier of the Ross Sea on July 6th, 1911, by Captain Scott's expedition." We believe that there is an authentic reading of 205a (751 Kelvingrads,—68° C.,—90° F.) at Verkhoyansk, February 5–7, 1891. This is erroneously given several degrees lower in Woeikof's "Meteorologie," 1910. In this chapter no mention is made of Professor Humphreys' explanation of the cause of the stratosphere: although proper mention is made of Gold's work on what may be called the radiation balance sheet for different levels of the atmosphere.

Other chapters deal with the thermal structure of the atmosphere, origin of changes of pressure, tropical storms, and the chemical composition of the atmosphere.

ALEXANDER MCADIE

CLIMATOLOGICAL ATLAS OF GERMANY

G. HELLMANN AND OTHERS. **Klima-Atlas von Deutschland.** 63 pp. of maps, 40 pp. of text. Dietrich Reimer (Ernst Vohsen), Berlin, 1921. $7.00 bound. 12 x 14 inches.

The Prussian Meteorological Institute, with an enviable record of effective service to meteorology behind it, has added another important volume to its already long list of valuable publications. In the new "Klima-Atlas" of Germany, we have presented all the

essential facts concerning the climates of Germany (with the area it had before the war), both in cartographic and in tabular form. That the work was done under Hellmann is a sufficient guarantee of its accuracy. To him and to his co-workers, Professors G. von Elsner and H. Henze and Dr. K. Knoch, climatologists are under a real debt.

The Atlas includes 87 colored charts and 16 tables of climatic data. The scale of the maps is partly 1 : 4,250,000, partly 1 : 8,500,000, and, in the case of the monthly rainfall maps, 1 : 1,250,000, in order that the local peculiarities of the distribution of precipitation may be clearly brought out. The basic period is in general 30 years, 1881–1910, except in the case of rainfall, where it is 20 years (1893–1912). These periods were selected because they include the largest series of reliable homogeneous observations. All records covering shorter periods than these were reduced to the basic periods.

The charts show the annual and monthly isotherms, isobars and average wind directions, and vapor pressures, all at sea level; also the relative humidity, cloudiness, and precipitation at the earth's surface. There are, in addition, single charts of the annual range of the monthly mean temperatures, the mean annual number of days with rainfall of at least 0.1 millimeter; of days with snowfall (melted) of at least 0.1 millimeter; and of the month of greatest rainfall; least rainfall; greatest and smallest number of rainy days (0.1 millimeter and over); average annual number of clear days and average annual number of cloudy days. The rainfall maps are especially instructive because of the light they throw on the local topographic effects, which are well marked in the south and west, while the distribution of rainfall over the great lowlands of the north and east is fairly uniform. Further, the general warm-season, "continental" rainfall maximum is clearly seen on comparing the winter with the summer maps.

Many comments suggest themselves to the reviewer, but to begin with details would inevitably lead to a lengthy discussion. Three points only will be noted. The first is the interesting fact that the northern base of the Harz Mountains as well as of the Alps shows, in several months and for the year, local favorable temperature conditions which are doubtless due to the *föhn* wind. The second comment concerns the absence of any charts of actual (surface) temperatures. While sea-level isotherms are indispensable in any broad studies of the controls of climate by land and water, it is the actual temperatures, not reduced, that are dominating factors in plant and animal life. As time goes on and as more complete temperature observations become available, isothermal charts showing actual temperatures will inevitably be more and more often used. It would seem that in the case of Germany, with a fairly fine-meshed net of meteorological stations, charts showing the actual temperatures might even now be drawn with a very reasonable degree of accuracy and without the necessity of too much interpolation. The third comment concerns a rather conspicuous absence of sunshine maps in the Atlas. The explanation, as is to be expected, is the lack of sufficient data for constructing good maps of this sort.

Those who have kept in touch with recent publications on the climatology of Germany will see in the new Atlas the completion, in final form, of numerous studies by Hellmann which have appeared during the past two decades. Mention may here be made of a considerable series of small rainfall maps of separate parts of Germany, with brief discussion, and a general rainfall map of the country as a whole, the first edition of which bears the date 1906 and the second 1919 (Dietrich Reimer, Berlin). There are two other recent papers on rainfall ("Neue Untersuchungen über die Regenverhältnisse von Deutschland," Erste Mitteilung, *Sitzungsber. Königl. Preuss. Akad. der Wiss.*, Berlin, 1919, Part I, pp. 417–432; Zweite Mitteilung, *ibid.*, 1921, pp. 246–257). The second of these papers shows lines of equal annual numbers of days with snowfall. Hellmann has also recently published a paper on the isotherms of Germany ("Die Isothermen von Deutschland," *ibid.*, 1920, pp. 369–376; Pls. 2) and on cloudiness in Germany ("Die Nebel in Deutschland," *ibid.*, 1921, pp. 900–919).

R. DeC. Ward

Irrigation as an Institution in the West

George Thomas. **The Development of Institutions under Irrigation, with Special Reference to Early Utah Conditions.** vii and 293 pp.; map, ill., index. (The Rural Science Ser., L. H. Bailey, edit.) The Macmillan Co., New York, 1920. $2.75. 7½ x 5 inches.

Dr. Thomas has made a valuable contribution to the literature of irrigation in the United States. The first attempts in this country to develop irrigation co-operatively

were made in Utah seventy-five years ago. From this beginning the evolution of the legal and social institutions of irrigation has been rapid, and a wide diversity of results has been achieved.

This evolution, as it has gone on in Utah, has been conscientiously reviewed in the present book. The story is told in simple language and illustrated with bits of early history that serve their purpose well.

One of the best features of the book is the account of how the doctrine of riparian rights, which comes to us from English common law, has been modified by the need of validating the right to appropriate water for beneficial use. This account is simply stated and well illustrated by specific cases.

The author holds strong views as to what is sound irrigation law and what is not. He believes that appropriated water should be appurtenant to definite tracts of land and that in the arid states the actual ownership of the water should remain with the public, that is with the state.

It is clear that seventy-five years has not been long enough, in Utah at least, to work out and put into practice a satisfactory body of irrigation laws and adequate machinery for their administration.

It is unfortunate the work is marred by lack of editing. This is shown in the needless repetition of some of the cases cited as well as by a certain monotony of treatment.

C. S. SCOFIELD

A REFERENCE WORK ON CENTRAL AMERICA

KARL SAPPER. **Mittelamerika.** 124 pp.; map, bibliogr., index. (Auslandswegweiser, herausg. von dem Hamburgischen Welt-Wirtschafts-Arciv und dem Ibero-amerikanischen Inst., Vol. 5.) L. Friederichsen & Co., Hamburg, 1921. 7½ x 5½ inches.

A work by Sapper on Central America is always an event of geographic importance because of his devotion to the geography of this region and his many contributions to it. The present work is important not because of any contribution to geographical theory but for its systematic treatment of the geographic and economic elements of Central America. It is a standard reference book on the subject, with up-to-date statistics and statistical analyses and explanations, together with an excellent map in color, on the scale 1 : 10,000,000. Throughout the book there is attention to the outstanding geographical controls, and this makes the organization of the material particularly valuable. The strong regional contrast between the Atlantic and the Pacific slopes of Central America is brought out and forms, in fact, a dominant note in the life of the region from the earliest settlement down to the present time.

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